MODEL CALIBRATION DATA

This appendix includes:

- Calibration Field Testing Plan
- Calibration Data
- Model Calibration Results
  - Reservoirs
  - Pump Stations
  - Metering Station
  - Temporary Pressure Loggers

Appendix D

CALIBRATION PLAN

City of Carlsbad

RECYCLED WATER MASTER PLAN UPDATE

MODEL CALIBRATION PLAN

FINAL
September 2009

City of Carlsbad

RECYCLED WATER MASTER PLAN UPDATE

MODEL CALIBRATION PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 OVERVIEW

This calibration plan covers each of the calibration processes, specifically focusing on data gathering needs to ensure an accurate and complete calibration.

1.1 Schedule

Field testing and data gathering for the spring model calibration will tentatively take place during the first week of October, from the 5th through the 11th. Table 1 presents a preliminary schedule of this week, detailing on which days each data gathering element of the calibration will take place. This will allow our team to start the model calibration as soon as possible following the week of calibration data gathering.

Table 1 Calibration Data Gathering and Testing Schedule
Recycled Water Master Plan Update
City of Carlsbad

Sunday September 27	Monday September 28	Tuesday September 29	Wednesday September 30	Thursday October 1	Friday October 2 **Finalize PLs Locations**	Saturday October 3
Sunday October 4	Monday October 5 **Install PLs**	Tuesday October 6 **PL Start Recording**	Wednesday October 7 **EPS Data Gathering**	Thursday October 8 **EPS WQ Sampling**	Friday October 9 **EPS Data Gathering**	Saturday October 10 **EPS Data Gathering**
Sunday October 11 **EPS Data Gathering**	Monday October 12 **Remove PLs**	Tuesday October 13 **Provide SCADA to our team**	Wednesday October 14	Thursday October 15	Friday October 16	Saturday October 17

Abbreviations: EPS: Extended Period Simulation; PLs: Pressure Loggers; WQ: Water Quality.

The remainder of this plan details the data required for each calibration and testing procedures for each portion of the calibration test.

2.0 EXTENDED PERIOD CALIBRATION

2.1 Overview of Extended Period Calibration Process

The extended period calibration is intended to calibrate the extended period simulation (EPS) capabilities of the hydraulic model by closely matching the model pressures, flows, and tank levels to field conditions over a 24 hour period of similar demand and system boundary conditions. Pressure data, tank levels, and flows from the water reclamation plants, booster stations, and the pressure reducing stations will be recorded for a full week in order to create diurnal patterns and obtain EPS calibration data. The primary varied parameters for this calibration will be operational controls and pipeline roughness coefficients; although other parameters may also be adjusted as calibration results are generated.

2.2 Data Required for Extended Period Calibration

The calibration data required for the extended period calibration consists of records of system pressures, tank levels, and flows from the water reclamation plants, booster stations, and the pressure reducing stations throughout the distribution system. These system pressures will be gathered both by the City's existing sensor network and by temporary pressure loggers, which will be attached by plumbing into existing air release valves (ARV) and meters throughout the distribution system. Additional data, including system controls and operational details, will be required to establish boundary conditions for the model. This data will be gathered over the course of the week (See Table 1 for the complete calibration schedule).

A target system interval of 15 minutes will be used for data gathering. If any facilities listed lack the capabilities for 15 minute interval data gathering (e.g., they use circular charts or flow totalizers), assumptions will be necessary to interpolate data for the calibration.

The calibration data required for EPS calibration is listed by site in Table 2 and is shown geospatially on Figure 1. Figure 1 also shows the location of the temporary pressure loggers, along with each facility of the recycled water distribution system for which data is required. Following Figure 1 is a series of zoomed in locations, Figures 1a through 1k.

Table 2 EPS Calibration Data Gathering Parameters
Recycled Water Master Plan Update
City of Carlsbad

Facility Name	Measurement	Unit	Interval	Source
Reservoirs				
D-1 Tank	level	ft	15 min	SCADA
D-2 Tank	level	ft	15 min	SCADA
C Tank	level	ft	15 min	SCADA
Mahr Reservoir	level	ft	15 min	SCADA

Table 2 EPS Calibration Data Gathering Parameters (Continued)
Recycled Water Master Plan Update
City of Carlsbad

Facility Name	Measurement	Unit	Interval	Source
Pressure Reducing Stations				
Faraday PRV	Percent Open	%	15 min	SCADA
	suction pressure	psi	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Corinthia MOV	flow	gpm	15 min	SCADA
	suction pressure	psi	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Avenida Encinas PRV	Percent Open	%	15 min	SCADA
	suction pressure	psi	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
La Costa PRV	Percent Open	%	15 min	SCADA
	suction pressure	psi	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Twin D PRV	Percent Open	%	15 min	SCADA
	suction pressure	psi	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Dump Valve	Percent Open	%	15 min	SCADA
(to Reclaimed Water Basins)	suction pressure	psi	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Booster Stations				
Bressi Pump Station	flow	gpm	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Twin D Pump Station	flow	gpm	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Calavara Pump Station	flow	gpm	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Encina Pump Station	flow	gpm	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Pressure Loggers				
EPS-1 – Figure 1a	pressure	psi	15 min	PL
EPS-2 – Figure 1b	pressure	psi	15 min	PL
EPS-3 – Figure 1c	pressure	psi	15 min	PL
EPS-4 – Figure 1d	pressure	psi	15 min	PL
EPS-5 – Figure 1e	pressure	psi	15 min	PL
EPS-6 – Figure 1f	pressure	psi	15 min	PL
EPS-7 – Figure 1e	pressure	psi	15 min	PL
EPS-8 – Figure 1g	pressure	psi	15 min	PL
EPS-9 – Figure 1h	pressure	psi	15 min	PL
EPS-10 – Figure 1i	pressure	psi	15 min	PL
EPS-11 – Figure 1j	pressure	psi	15 min	PL
EPS-12 – Figure 1i	pressure	psi	15 min	PL
EPS-13 – Figure 1h	pressure	psi	15 min	PL
EPS-14 – Figure 1k	pressure	psi	15 min	PL
EPS-15 – Figure 1e	pressure	psi	15 min	PL
Connections (System Inflows)				
Vallecitos Water District's	flow	gpm	15 min	SCADA
Meadowlark WRF	discharge pressure	psi	15 min	SCADA

Table 2 EPS Calibration Data Gathering Parameters (Continued) Recycled Water Master Plan Update City of Carlsbad				
Facility Name	**Measurement**	**Unit**	**Interval**	**Source**
Leucadia County Water District's	flow	gpm	15 min	SCADA
Gafner WWTP[2]	discharge pressure	psi	15 min	SCADA
Twin D Potable PRV[1]	flow	gpm	15 min	SCADA
	suction pressure	psi	15 min	SCADA
	discharge pressure	psi	15 min	SCADA
Connections (System Outflows)				
	flow	gpm	15 min	SCADA
Olivenhain MWD	suction pressure	psi	15 min	SCADA

Notes:
1) Supplemental potable water is introduced to the recycled water system when the D Tanks reach a low water level. Supplied to system at this location which is an 8-inch diameter combination pressure reducing and sustaining valve.
2) The Gafner WWTP currently supplies recycled water only to the south golf course of the La Costa Spa and Resort. The main water system is supplied entirely from Meadowlark WRF.

Abbreviations: CC = Circular Chart; FT = Flow Totalizer; PL = Pressure Logger; PRS = Pressure Reducing Station.

2.3 Format of Data

2.3.1 SCADA Data

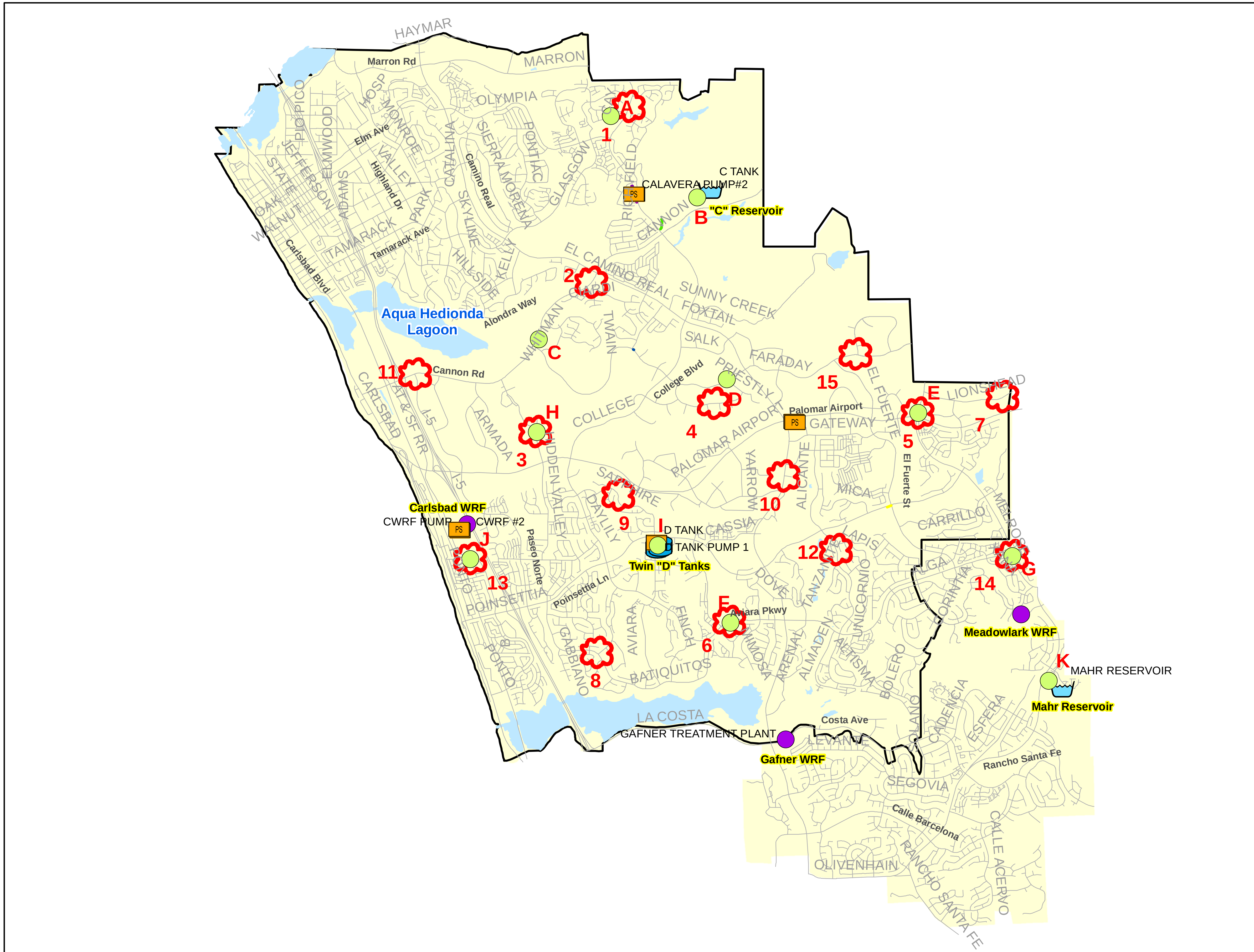
All SCADA data needs to be provided in MS Excel or a MS database format. The number of data points for each facility is estimated to be slightly over 2000 points for each of the 39 SCADA data fields requested. Table 3 presents an acceptable sample format for the SCADA data.

Table 3 Sample SCADA Data Format Recycled Water Master Plan Update City of Carlsbad							
TANK3_LEVEL		**TANK2_LEVEL**		**RWC1_PRESSURLZ**		**PS9_PRESSUR_SUCT**	
time	**ft**	**time**	**ft**	**time**	**psi**	**time**	**gpm**
2/1/09 1:05	27.61	2/1/09 1:04:54	25.73	2/1/09 1:03:49	44.53	2/1/09 1:03:17	120.59
2/1/09 1:20	27.52	2/1/09 1:20:22	25.54	2/1/09 1:21:45	44.65	2/1/09 1:21:55	117.05
2/1/09 1:35	27.35	2/1/09 1:34:27	25.39	2/1/09 1:33:25	44.20	2/1/09 1:32:35	119.63
2/1/09 1:50	25.12	2/1/09 1:50:39	25.29	2/1/09 1:51:53	45.34	2/1/09 1:52:21	119.42
2/1/09 2:05	25.59	2/1/09 2:04:05	25.13	2/1/09 2:03:23	45.13	2/1/09 2:02:24	115.52
2/1/09 2:20	25.60	2/1/09 2:20:29	27.56	2/1/09 2:21:20	45.26	2/1/09 2:22:13	117.21
2/1/09 2:35	25.55	2/1/09 2:34:27	27.60	2/1/09 2:33:29	44.59	2/1/09 2:32:52	117.29
2/1/09 2:50	27.96	2/1/09 2:50:09	27.90	2/1/09 2:50:46	45.01	2/1/09 2:51:00	117.05
2/1/09 2:05	25.76	2/1/09 2:04:04	27.67	2/1/09 2:03:12	45.75	2/1/09 2:02:55	116.55
2/1/09 2:20	25.41	2/1/09 2:20:17	26.51	2/1/09 2:21:53	44.22	2/1/09 2:22:02	116.91
2/1/09 2:35	25.56	2/1/09 2:34:45	27.31	2/1/09 2:33:56	44.42	2/1/09 2:33:03	115.15
2/1/09 2:50	25.06	2/1/09 2:50:02	26.96	2/1/09 2:50:35	45.04	2/1/09 2:51:26	119.02

Table 3 Sample SCADA Data Format
Recycled Water Master Plan Update
City of Carlsbad

2/1/09 3:05	25.11	2/1/09 3:04:24	27.00	2/1/09 3:04:13	44.17	2/1/09 3:03:25	120.00

Notes:
This sample was taken from a different SCADA system and thus may not represent the exact format of the City's SCADA output.



Legend

- Chlorine Resdiual Sampling Locations
- General Location of Pressure Logger
- pump_FeatureToPoint
- WRF
- Reservoir
- Tank
- Streets
- Water Body
- Carlsbad Municipal Water District
- City Limits

0 5,000 10,000 Feet

Figure 1
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

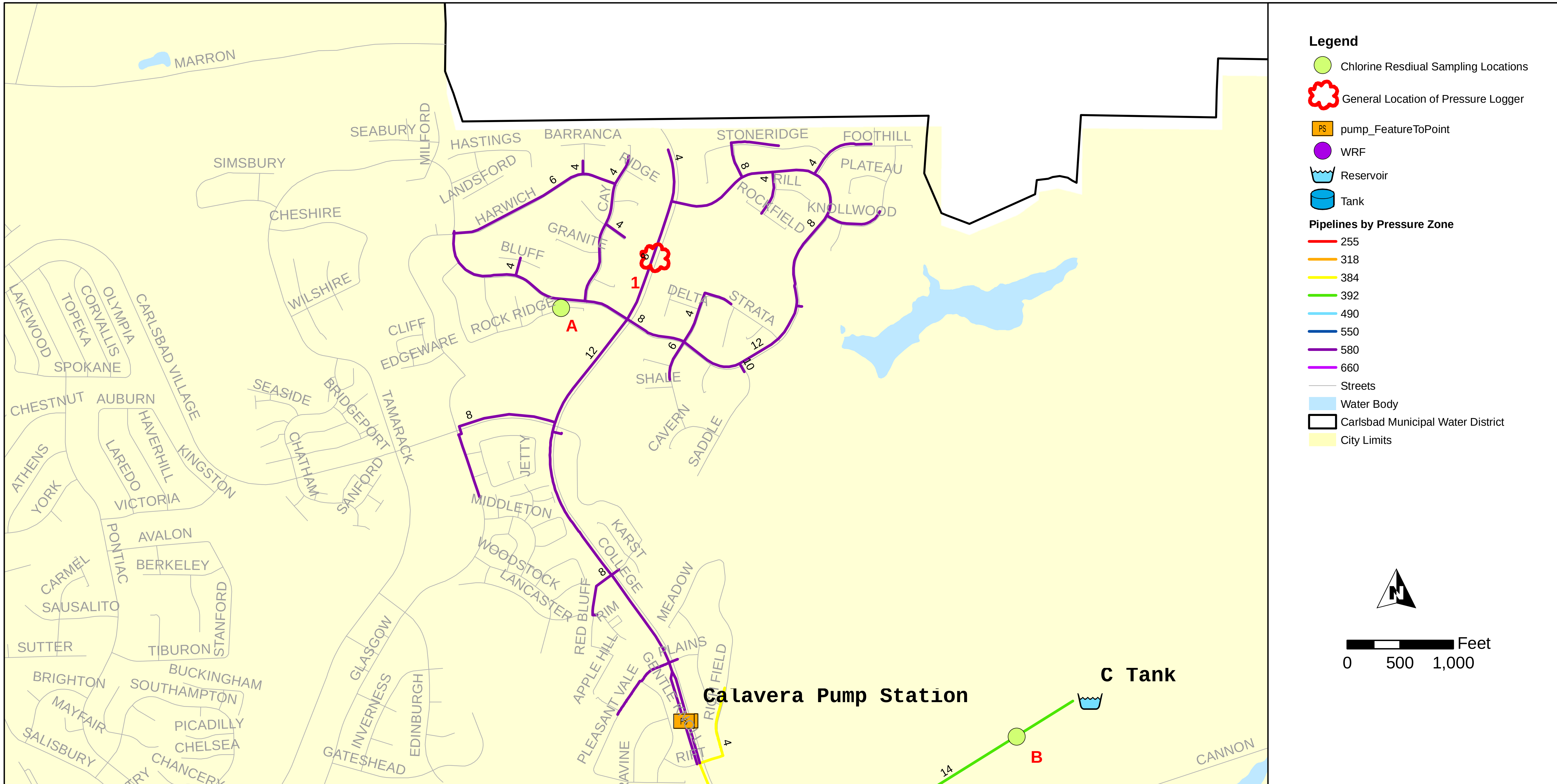


Figure 1a
Temporary Pressure Logger and
Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

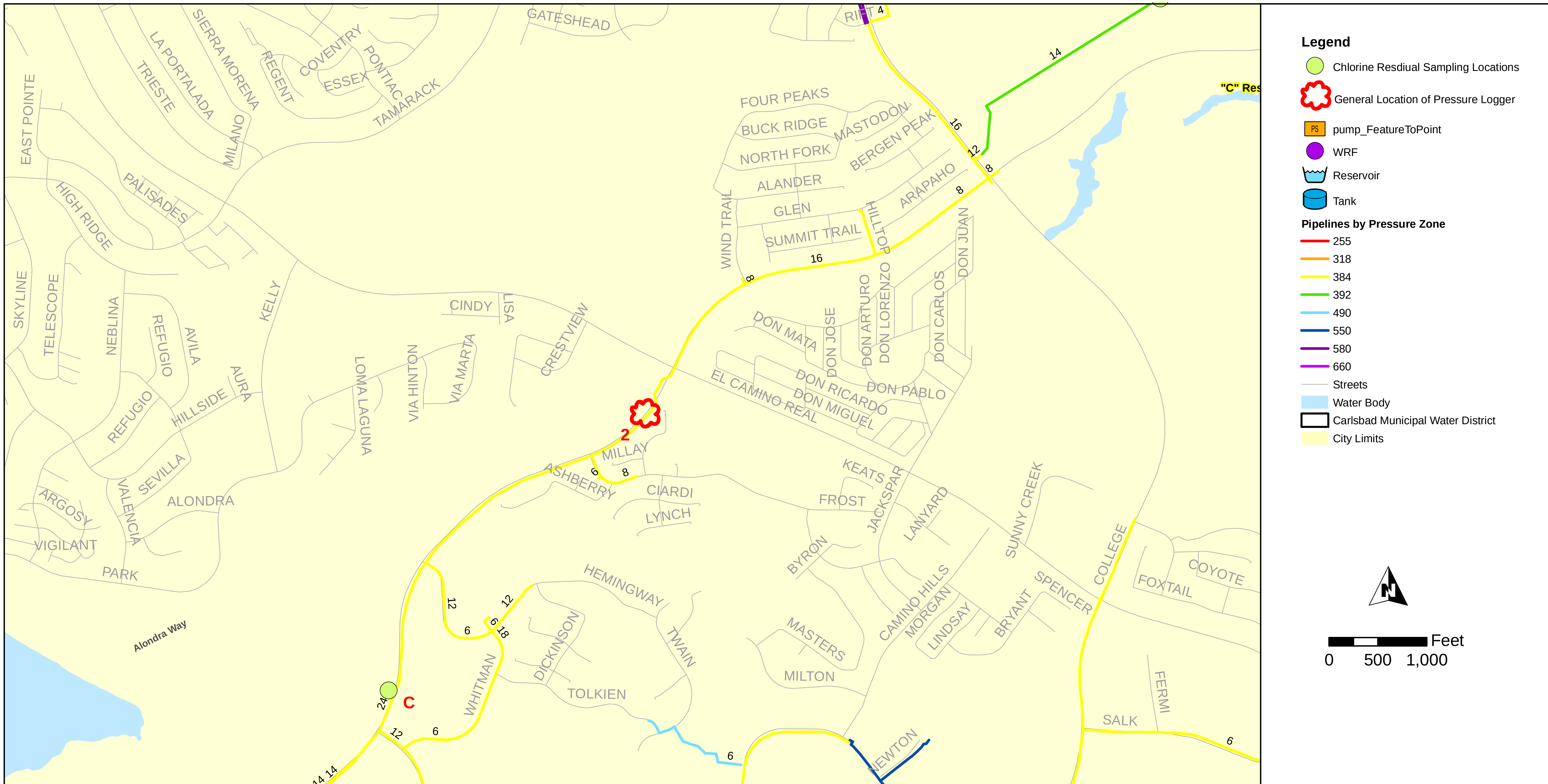


Figure 1b
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

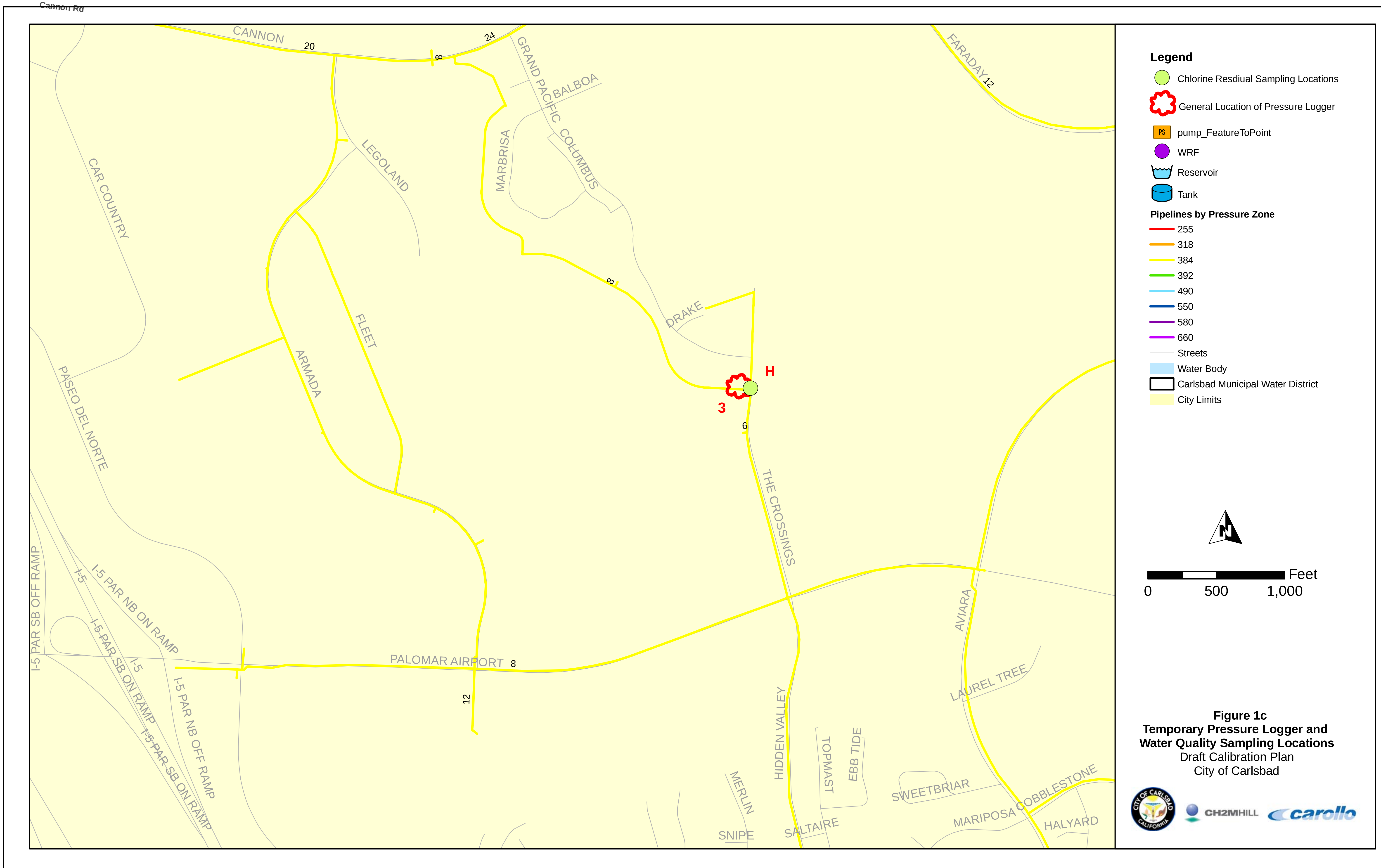


Figure 1c
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

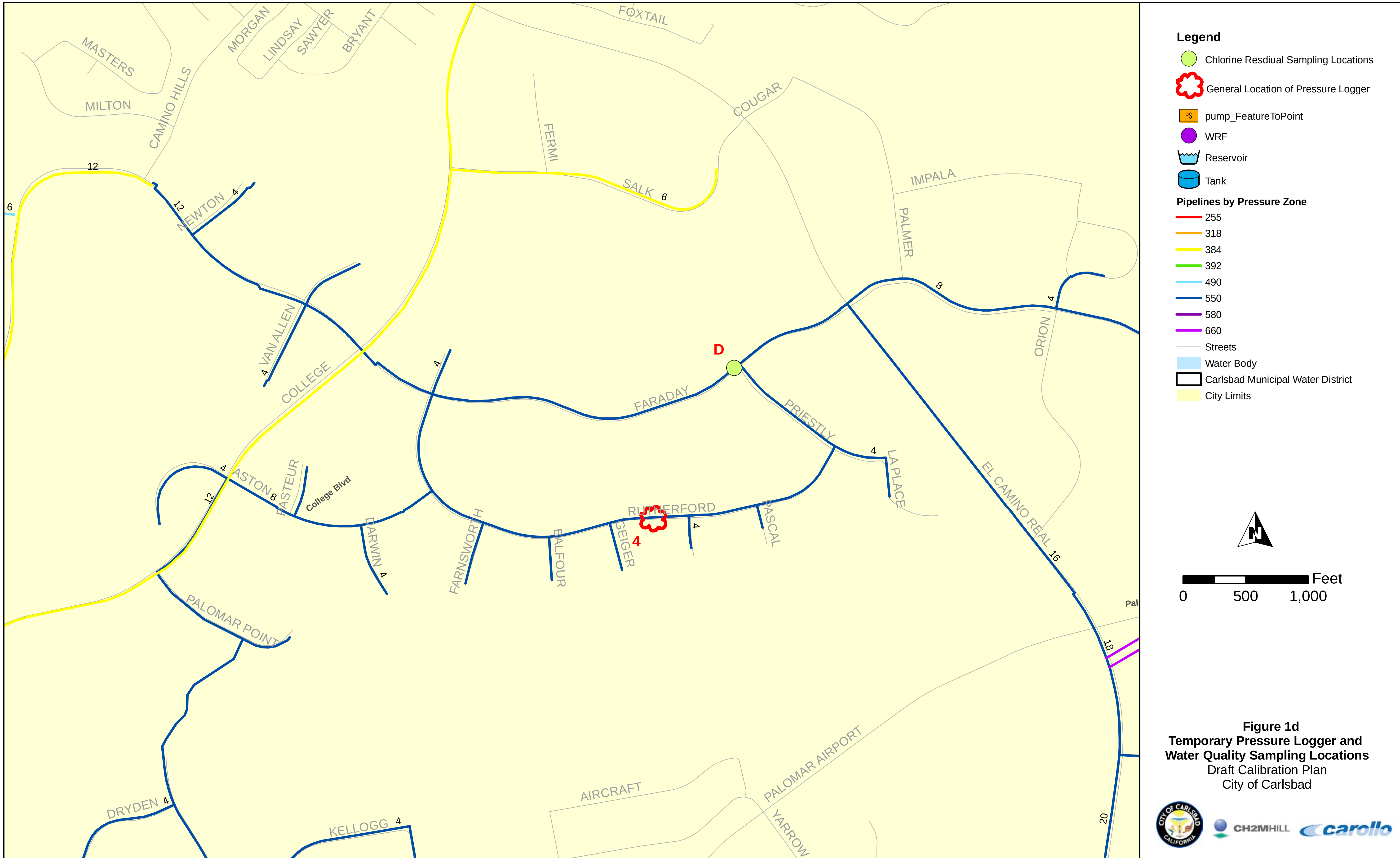


Figure 1d
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

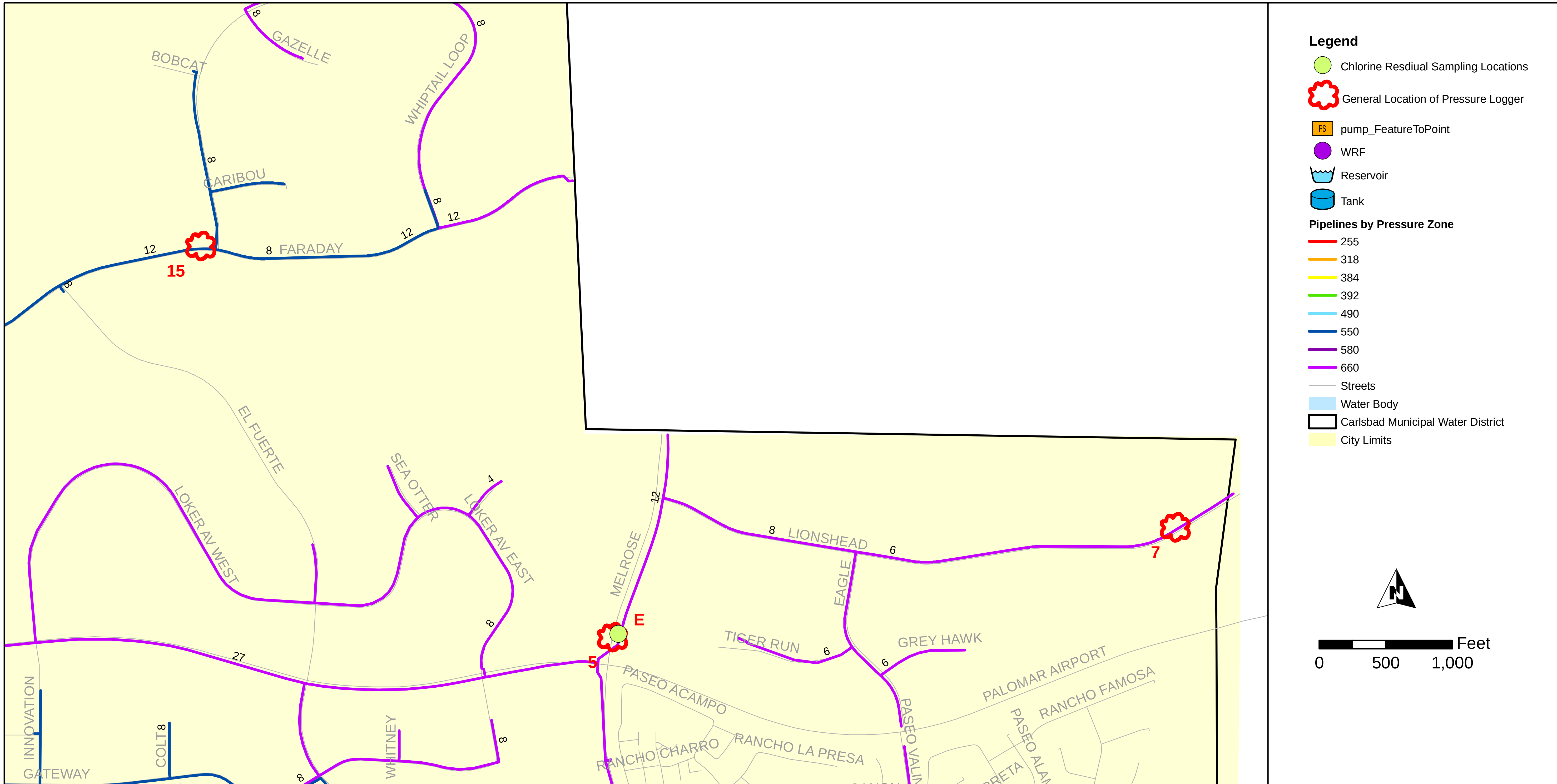


Figure 1e
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

CH2MHILL carollo

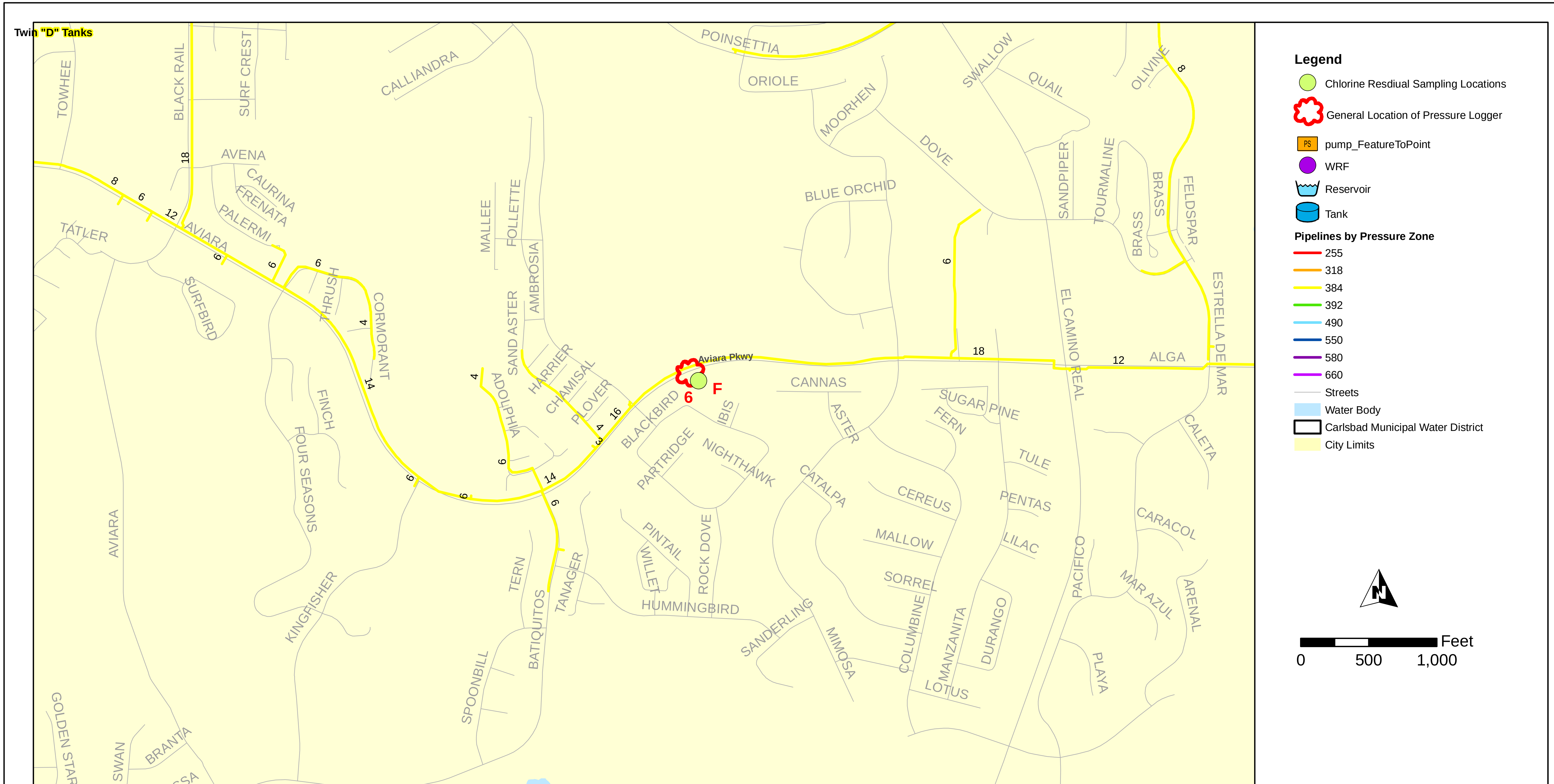


Figure 1f
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

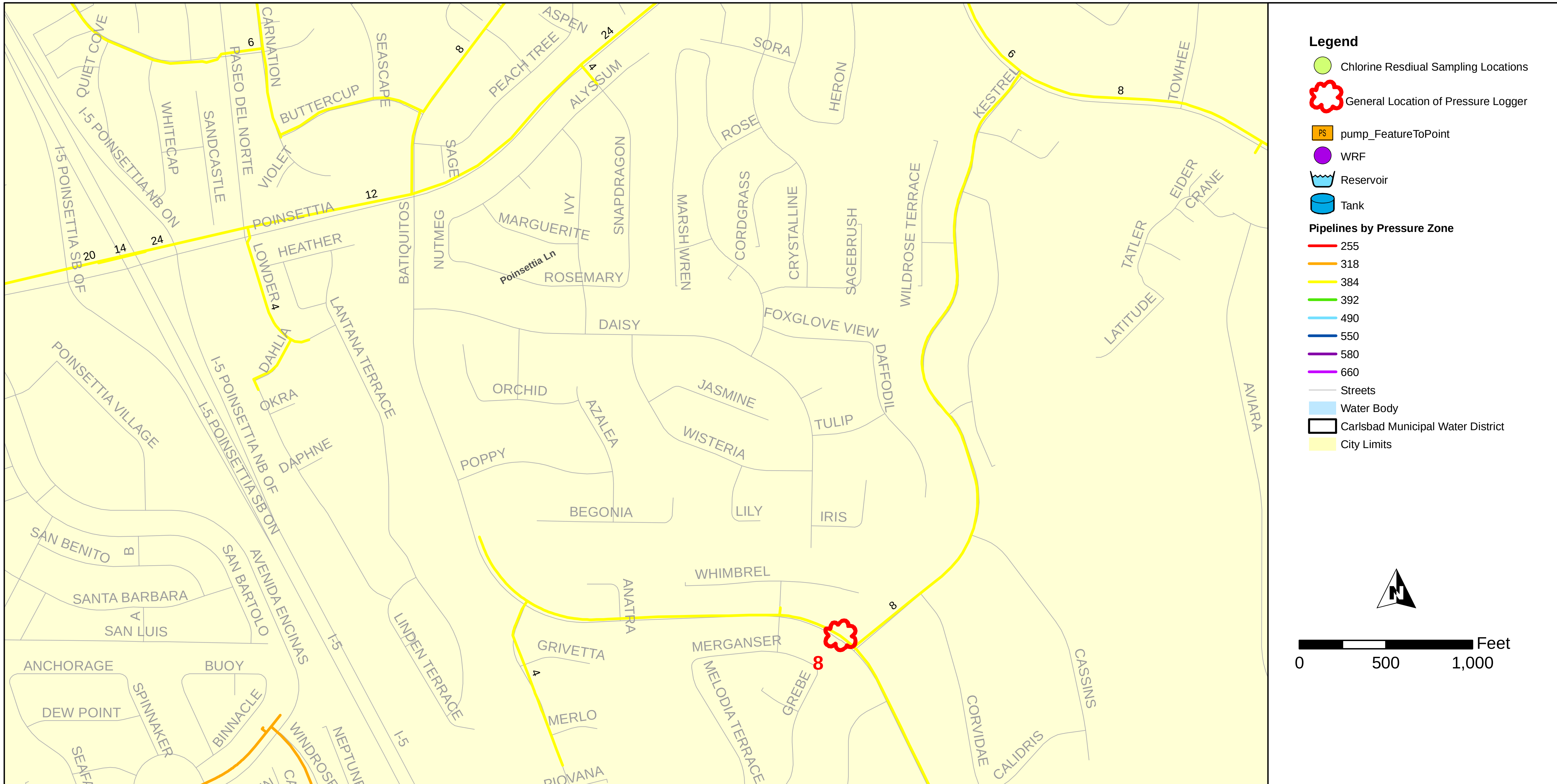


Figure 1g
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

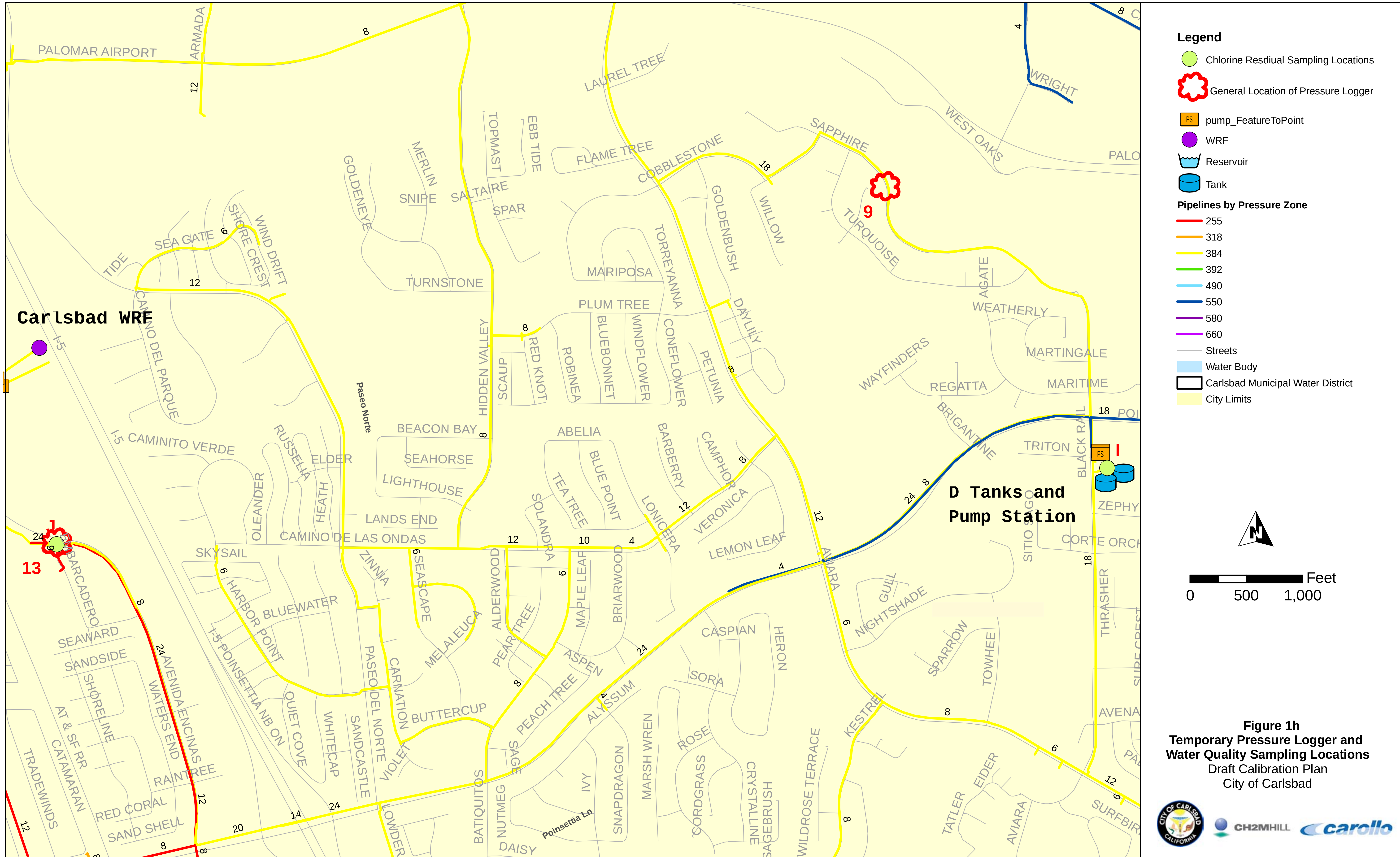


Figure 1h
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

CITY OF CARLSBAD CALIFORNIA
CH2MHILL
carollo

Figure 1i
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

Legend

- Chlorine Resdiual Sampling Locations
- General Location of Pressure Logger
- pump_FeatureToPoint
- WRF
- Reservoir
- Tank

Pipelines by Pressure Zone

- 255
- 318
- 384
- 392
- 490
- 550
- 580
- 660
- Streets
- Water Body
- Carlsbad Municipal Water District
- City Limits

Feet
0 500 1,000

Figure 1j
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

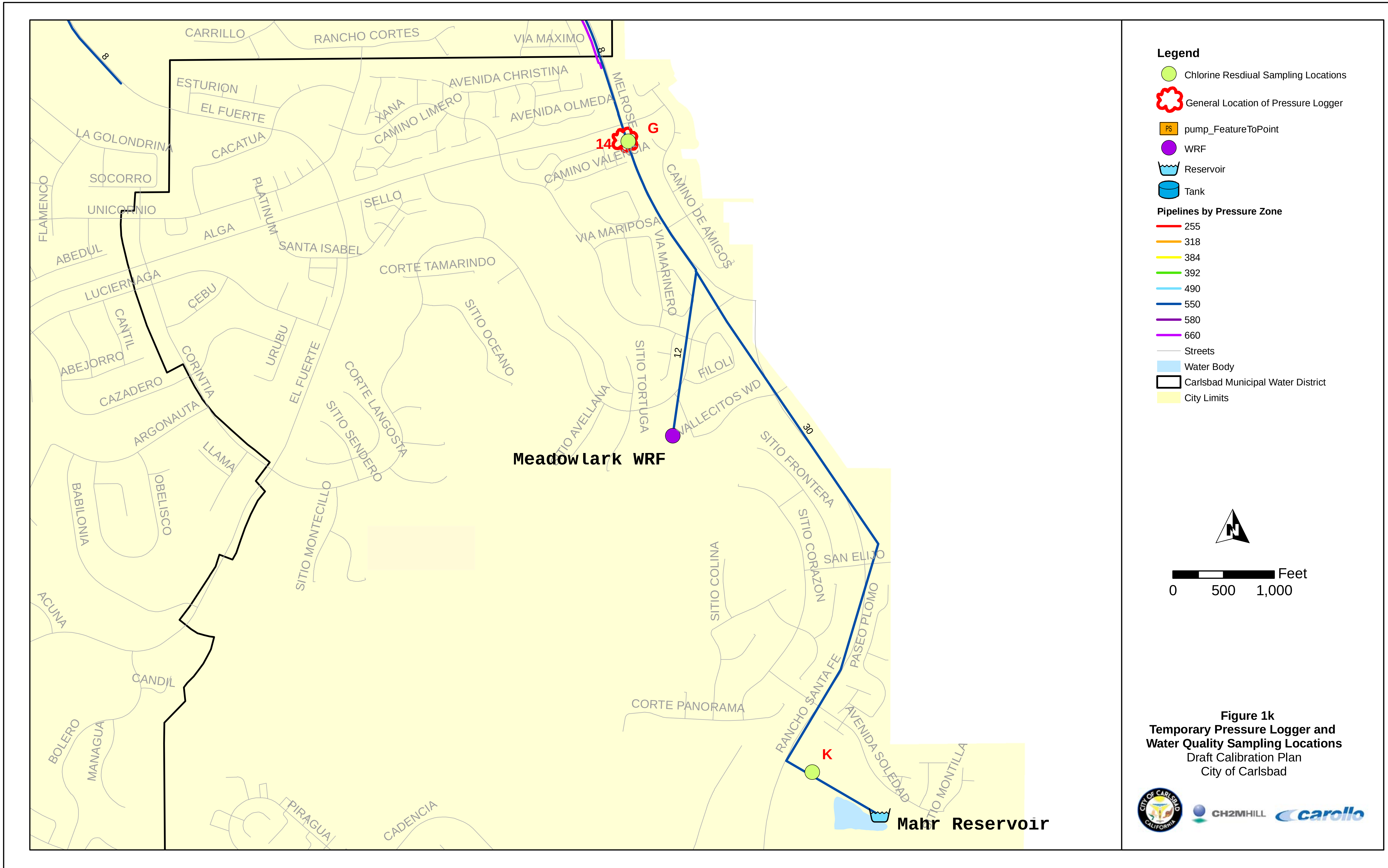


Figure 1k
Temporary Pressure Logger and Water Quality Sampling Locations
Draft Calibration Plan
City of Carlsbad

Depending on the interval of data available and record keeping capabilities of the SCADA system, modifications may need to be made to the SCADA system prior to the calibration week (and impacting the schedule). It would be preferable to our team to obtain SCADA data on 5-minute intervals. However, hourly intervals would be sufficient if 5-minute intervals are not possible. If possible, the time of each data point should be included in the output report, especially if the SCADA data is queried from each facility independently.

2.3.2 Circular Charts

If required, our team will digitize any circular charts in hourly intervals for the data point that are not available on SCADA and listed in Table 2. The City should provide color copies of any circular charts for facility parameters requested. If the facility is offline for the duration of the entire EPS data-gathering period, there is no need to provide circular charts for that facility. If the City uses circle charts, the accuracy of these data points will be limited in comparison to SCADA data.

2.3.3 Manual Facilities

For any manually operated facilities listed in Table 2, an operational log should be substituted for the requested facility parameters. It is assumed that flow totalizers are used to take daily readings of the amount of recycled water pumped during each 24-hour period. For any manually operated pump used during the extended period calibration week, the hours that the pump is on or off, along with the flow rate during each operation period will be needed. Photocopies of the log sheets for these pumps would be sufficient. If the City finds it more convenient, a handwritten or electronic log of all sites would also be sufficient.

2.3.4 Temporary Pressure Loggers

Discussions with the City have indicated that locations to attach temporary pressure loggers are limited. City staff indicated that it will provide all 15 pressure loggers and that all the temporary pressure loggers can be plumbed onto air vacuum relief valves. Our team has indicated general locations for the 15 pressure loggers on Figure 1, with additional zoomed in detail shown in Figures 1a through 1k. City staff will install near these locations as local meters and appurtenances allow.

2.4 Required Equipment / Staff

2.4.1 Required Staff (City)

This task will require City employees to place all of the pressure loggers in the field on the initial day of testing (tentatively October 5th).

City staff shall be responsible for installation/removal of data loggers on hydrants, driving City vehicles or any other function involving City property.

2.4.2 Required Equipment (City)

- 15 pressure loggers – Dickson PR300
- appropriate wrenches and equipment to place loggers at each location

2.4.3 Required Equipment (Carollo/CH2M Hill)

- Maps of field locations for pressure loggers

2.5 Models and Intermediate Readings

The sampling interval for all pressure loggers should be set to 5 minutes. Each pressure logger will require approximately 2,016 data points (12 data points per hour over 7 days).

The pressure loggers are Dickson brand pressure loggers model PR300 marked CE2 through CE6. The internal capacity of these meters is limited to 7,936 data points, which is sufficient to record one week of data in 5-minute intervals.

3.0 WATER QUALITY CALIBRATION

The water quality calibration is intended to calibrate the water quality capabilities of the hydraulic model by matching its predicted chlorine residuals to laboratory tested chlorine residuals taken from sampling sites in the distribution system.

3.1 Overview of the Water Quality Calibration Process

The primary varied parameters for this calibration will be the wall and bulk reaction coefficients, although other parameters may also be adjusted as calibration results are generated. It should be noted that the calibration of Chlorine residuals in the City's distribution system will involve more engineering judgment and assumptions than the hydraulic calibration and that the results obtained from this process are subject to interpretation.

The key challenge is the fact that the chlorine samples are collected during the day, each representing different hydraulic conditions, while the results are typically compared as an instantaneous set of values. With only one sample at each location per day, the range in chlorine level at each location is not captured.

Also, the model will be unable to adequately model the hydraulics of mixing within the reservoirs. A computational fluid dynamic (CFD) model would need to be created for each reservoir in order to accurately determine how water quality changes within each reservoir. However, CFD modeling is complex and time consuming, and is not a part of this project.

Due to these and other unknown conditions, the water quality calibration results are typically not as accurate as hydraulic calibration, and the model results are therefore subject to interpretation. The proposed water quality calibration process consists of the following steps:

1. Chlorine Sampling

2. Establish Boundary Conditions

3. Water Quality Calibration

3.1.1 Step 1 - Chlorine Sampling

The proposed sampling sites for the calibration will consist of sampling sites throughout the distribution system and the water reclamation facilities, as presented on Figure 1 and shown in detail in Figures 1a through 1k. These sites are selected such that there is a good coverage of the entire distribution system and are located in close proximity to the proposed pressure logger locations to expedite field work. The exact locations of pressure recorders and water quality sampling may need to be adjusted slightly based on field conditions. Any sampling program that the City already follows could be incorporated into the water quality calibration data gathering. It is highly desired to conduct the water quality calibration in the same week as the EPS data gathering to record the hydraulic boundary conditions.

If both chlorine and chloromines are used, the water quality reports for each sampling site need to include both free and total chlorine residual. To get an idea of the range of chlorine levels during the day, it is requested that the City multiple samples throughout the day at each sampling location.

City operations staff have indicated they have the capabilities for analyzing chlorine residuals during sampling. Hence, no laboratory evaluation of chlorine residual will be required.

The chlorine decay factor for the system will need to be determined by taking samples near the supply sources and analyzing the sample over several days until the residual reaches zero. City staff have indicated that the chlorine residual discharged from the Meadowlark WRF is near zero already, so sampling will not provide decay curve results.

The sampling locations for jar tests are indicated on Figure 1 (near Carlsbad WRF pump station and the distribution system nearby). Samples should be taken at each location and analyzed daily (recording time and residual level) until the residual reaches zero.

3.1.2 Step 2 - Establish Boundary Conditions

To establish boundary conditions for the water quality model, the chlorination dosage at each point of entry into the distribution system will need to be input into the hydraulic model. The boundary conditions include:

- Chlorine concentrations in all reservoirs.

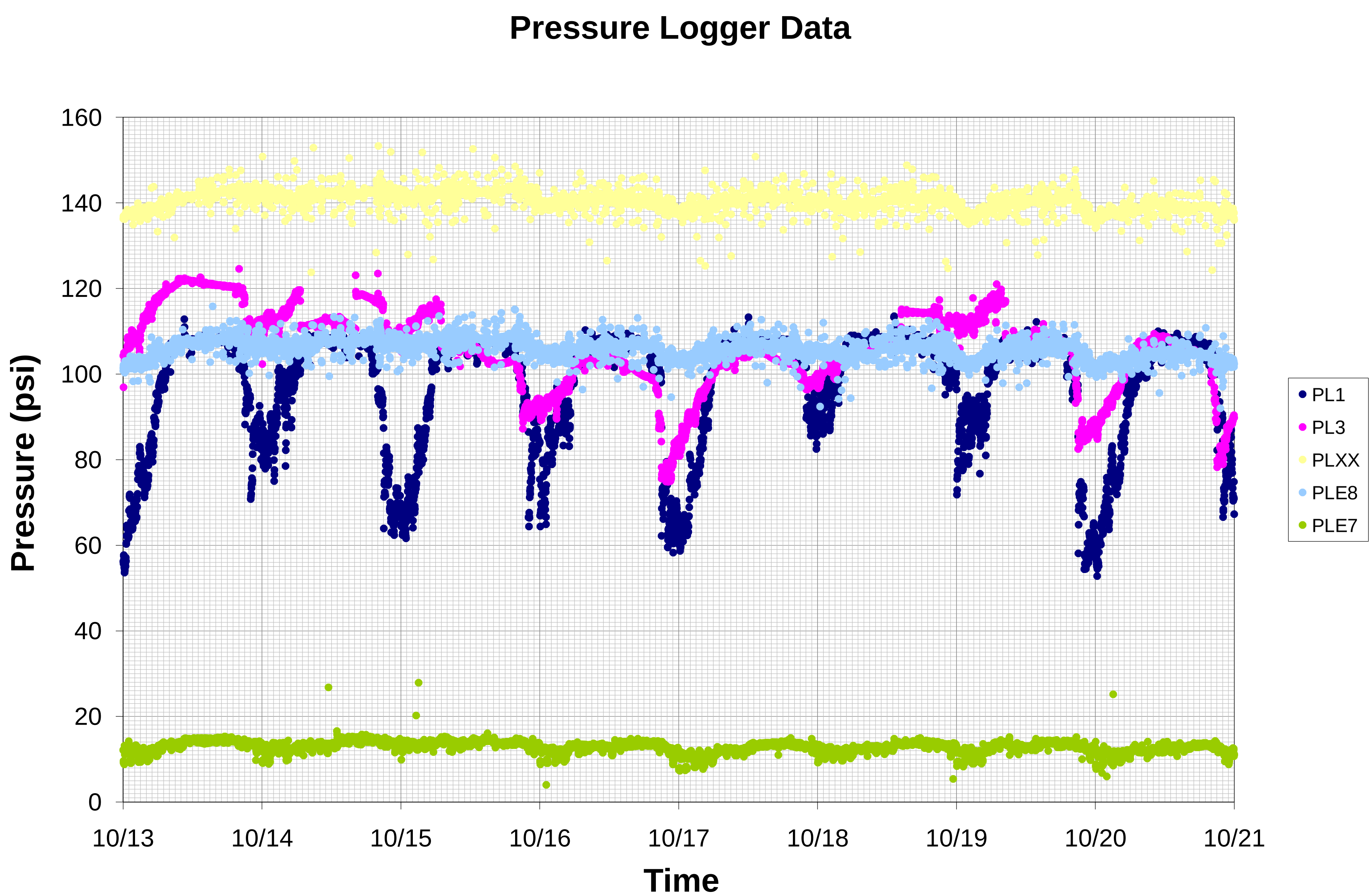
- Chlorine dosage at all wells and other dosing locations.

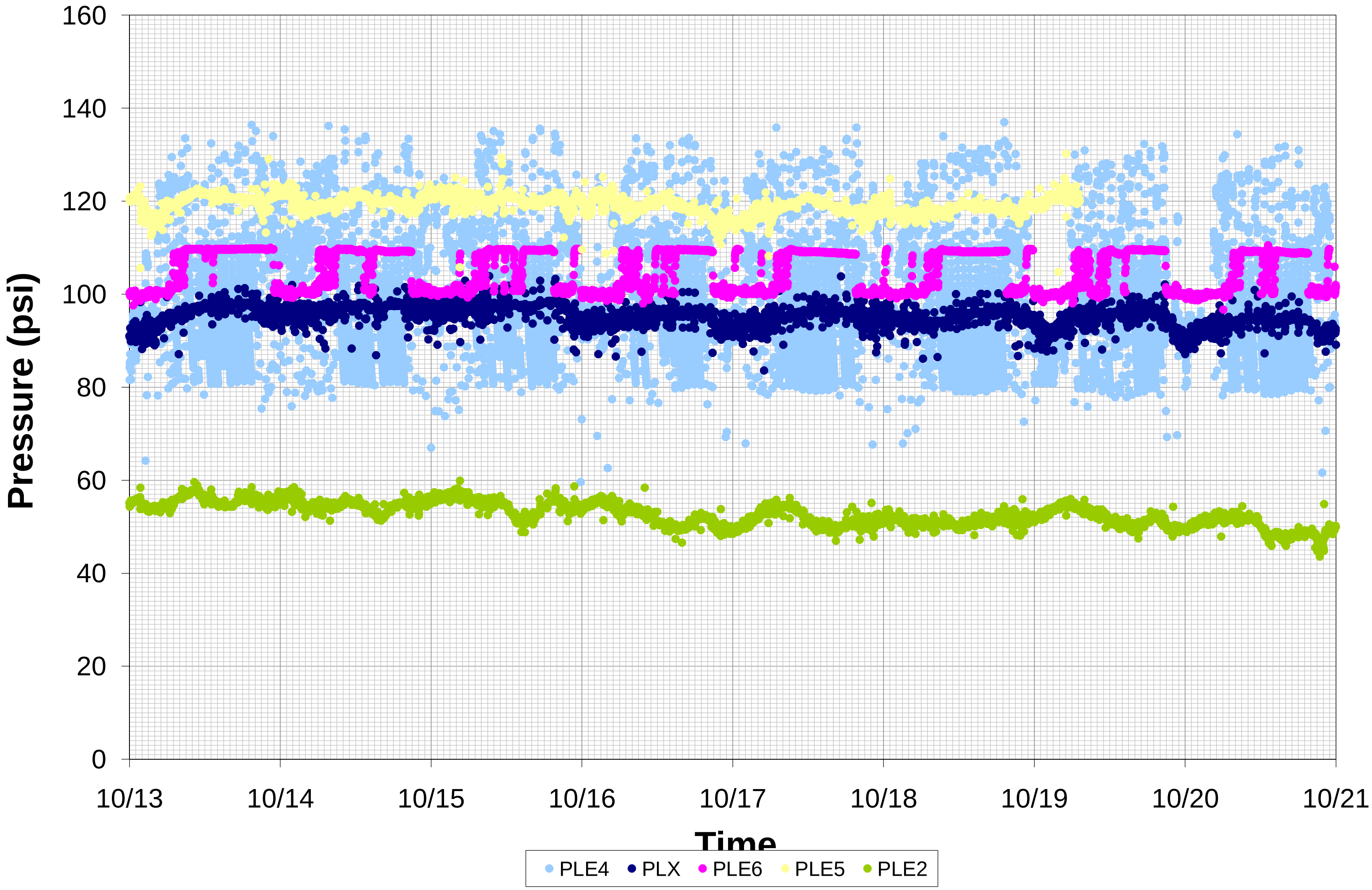
- Chlorine concentrations in the water provided through each water reclamation facility.

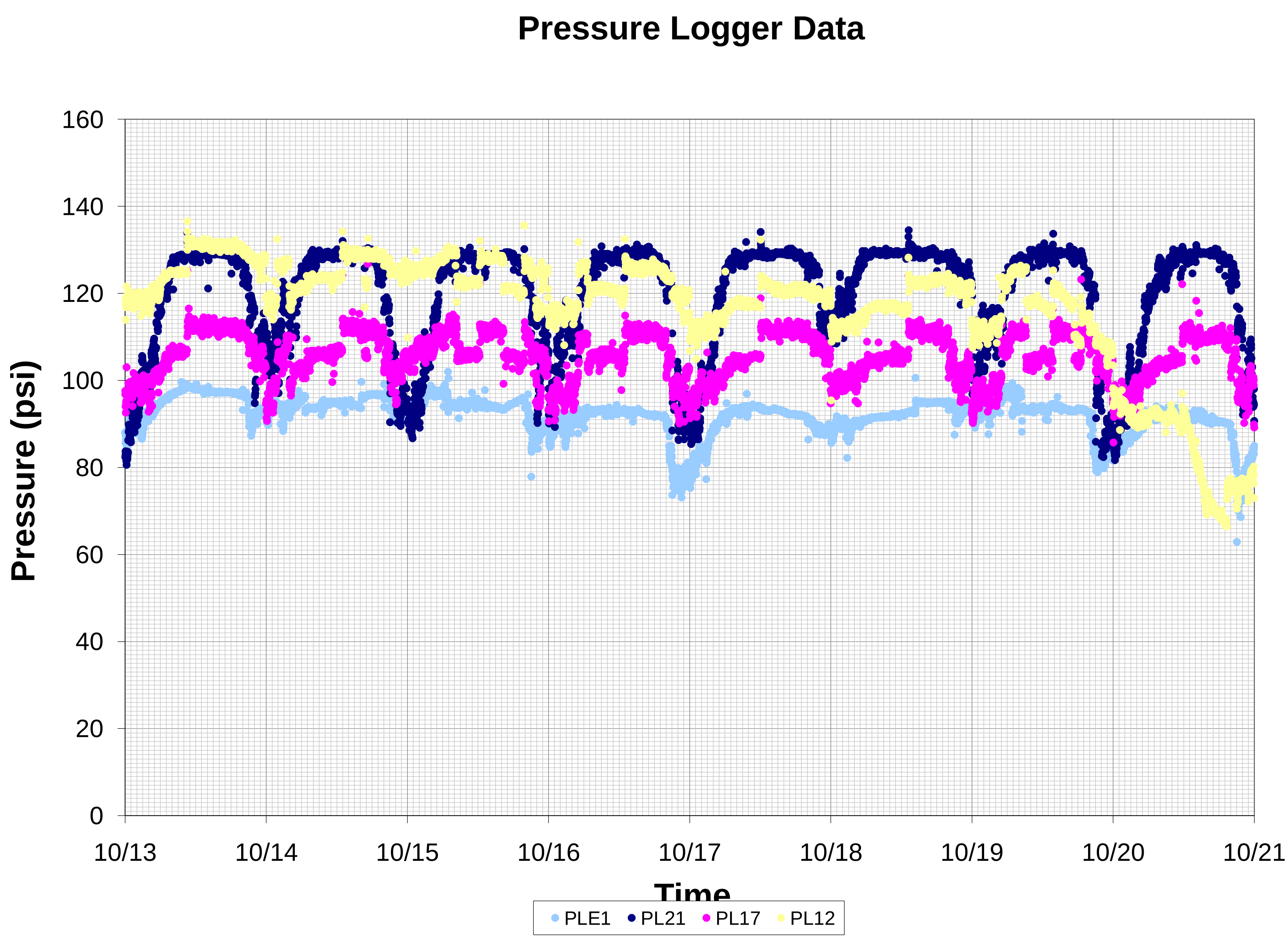
The sampled residual for each reservoir will be used as an initial condition within the model for each reservoir. An extended simulation will be used to check that the operational controls for the reservoir within the model maintain residual levels.

3.1.3 Step 3 - Water Quality Calibration

Calibration will be conducted by comparing the actual chlorine residual levels recorded at the sampling sites to the predicted values in the hydraulic model. First, the boundary conditions, such as initial concentrations and dosages will be input. Then, the free chlorine levels are calibrated by making model adjustments. Possible adjustments to the model include initial concentrations in the distribution system and/or reservoir operational controls and retention times, wall and bulk reaction coefficients in pipelines, and expanded investigation into any areas of influence of chloramines/chlorine interaction (if applicable).


Pressure Logger Data
Pressure (psi)
160
140
120
100
80
60
40
20
0
10/13
10/14
10/15
10/16
10/17
10/18
10/19
10/20
10/21
Time
PL1
PL3
PLXX
PLE8
PLE7


160
140
120
100
80
60
40
20
0
Pressure (psi)
10/13
10/14
10/15
10/16
10/17
10/18
10/19
10/20
10/21
Time
PLE4
PLX
PLE6
PLE5
PLE2



Pressure Logger Data
Pressure (psi)
160
140
120
100
80
60
40
20
0
10/13
10/14
10/15
10/16
10/17
10/18
10/19
10/20
10/21
Time
PLE1
PL21
PL17
PL12

593 = 53.0

2010 Recycled Water Master Plan

Datum = 540

Reservoirs

Measurement = Level (ft.)

Time Interval = 1:00

Date	Time	Mahr Reservoir (Datum = 540)	Twin "D" Tanks (Height = 40', spillway 39.5)	"C" Tank (Height = 32, spill = 30)
Fri. ~~Thur.~~ 10/15/09	6:00 PM	~~31.3~~ 30.0	22.3	15.9
	7:00 PM	~~31.2~~ 30.1	21.5	15.8
	8:00 PM	~~30.2~~ 30.3	20.6	15.5
	9:00 PM	30.3	18.5	14.8
	10:00 PM	30.2	15.0	13.3
	11:00 PM	30.0	14.2	12.2
Sat ~~Fri.~~ 10/16/09	12:00 AM	29.8	13.5	10.8
	1:00 AM	29.4	14.2	9.4
	2:00 AM	29.0	15.8	8.3
	3:00 AM	28.7	17.4	7.8
	4:00 AM	28.3	19.4	7.6
	5:00 AM	27.9	21.7	7.8
	6:00 AM	27.6	24.0	8.2
	7:00 AM	27.4	24.4	8.8
	8:00 AM	27.3	25.2	9.6
	9:00 AM	27.3	26.0	10.2
	10:00 AM	27.3	26.9	10.9
	11:00 AM	27.3	28.1	11.8
	12:00 PM	27.3	29.3	12.7
	1:00 PM	27.5	28.1	13.6
	2:00 PM	27.8	26.9	14.3
	3:00 PM	28.0	25.7	15.0
	4:00 PM	28.2	24.6	15.5
	5:00 PM	28.4	23.5	15.9
	6:00 PM	28.6	22.5	16.1
	7:00 PM	28.8	21.6	16.0
	8:00 PM	28.9	20.8	15.7
	9:00 PM	29.1	19.3	15.1
	10:00 PM	29.3	17.7	14.0
	11:00 PM	29.4	18.3	13.3
Sun ~~Sat.~~ 10/17/09	12:00 AM	29.3	19.3	12.7
	1:00 AM	29.2	22.0	12.3
	2:00 AM	29.1	21.9	11.9
	3:00 AM	28.8	21.7	11.8
	4:00 AM	28.7	21.1	11.3
	5:00 AM	28.6	20.6	10.4
	6:00 AM	28.4	20.5	10.0
	7:00 AM	~~29.3~~ 28.4	20.7	10.0
	8:00 AM	~~29.3~~ 28.4	21.1	10.1
	9:00 AM	~~29.3~~ 28.4	21.4	10.2
	10:00 AM	~~29.3~~ 28.4	21.8	10.4
	11:00 AM	~~29.3~~ 28.4	22.7	10.9
	12:00 PM	~~29.3~~ 29.4	24.1	11.6

2010 Recycled Water Master Plan

Pump Stations

only one pump running

only one pump running

only 2 Pump Running

Measurement = Flow(gpm)/Press.(psi)

Time Interval = 1:00

Date	Time	Encina/Carlsbad Flow	Encina/Carlsbad Disch	Encina/Carlsbad Suct.	Twin "D" (No pumps running)	Bressi Flow	Bressi Disch.	Pmp.1 [gpm]	Pmp 2 [gpm]	Calavara Flow	Calavara Disch	
~~Thur.~~ Fri 10/~~15~~16/09	6:00 PM	0	0/5.1		78.8	124.3	159.9			191	203	9
	7:00 PM				78.3	228.4	159.9			33.7	200.5	8
	8:00 PM				77.5	277.5	160.1			0	169.2	8
	9:00 PM				76.1	494.5	159.9			188	193	8
	10:12 ~~10:00 PM~~	3261			73.3	844.6	160.1			362	175	8
	11:00 PM	3224			69.6	1011	159.7			240	196	8
Sat ~~Fri.~~ 10/16/09	12:00 AM	3352			Ralph value opens drops press. 58.9	1065				574	173.7	8
	1:00 AM	3340			60.3	1065				365	175.7	8
	2:00 AM	3220			60.4	931				311	195.7	8
	3:00 AM	3216			59.8	900	160.3			130	168	8
	4:00 AM	3209			60.7	706	161			127	189	7
	5:00 AM	3175			61.1	514	160			1.8	180	8
	5:45 ~~6:00 AM~~	0			61.0	432				1.2	183	8
	7:00 AM				62.1	315				112	200.9	8
	8:00 AM				62.5	133				1.7	165.4	8
	9:00 AM				62.2	206				0	162	8
	10:00 AM				62.6	110				1.0	163.7	
	11:00 AM				62.6	100				1.2	164.7	
	12:00 PM				62.8	92				1.0	166	8
	1:00 PM				78.9	132				1.3	167.5	8
	2:00 PM				78.0	105				1.2		
	3:00 PM				78.3	17.4				0	170.9	
	4:00 PM				78.2	14.2				1.6	168	
	5:00 PM				78.6	76.				62	191	
	6:00 PM				78.0	11.4				—	161	
	7:00 PM				79.0	141				1.3	161	
	8:00 PM				78.4	197				1.2	172	
	9:00 PM				77.4	277				170	198	8
	10:12 ~~10:00 PM~~	3193			76.9	347				302	174	
	11:00 PM	3172			73.0	647				216	169	
Sun. ~~Sat.~~ 10/17/09	12:00 AM	3172			64.9	627				464	173	
	1:00 AM	3200			61.0	707				160	189	
	1:06 ~~2:00 AM~~	0			61.2	509				335	175	
	3:00 AM				61.8	432				116	192	
	4:00 AM				61.1	417				245	202	
	5:00 AM				61.6	262				259	184	
	6:00 AM				6.15	152				110	193	
	7:00 AM				62.2	130				1.2	162	
	8:00 AM				62.7	91				1.2	161	
	9:00 AM				62.6	73				—	177	
	10:00 AM				62.8	105				—	175	
	11:00 AM				63.0	16				1.0	177	
	12:00 PM					12.3	159.9					

Pmp.1: turns on about 1/hr. 10 MIN Run Time

Pmp.2: 120gpm ... hr. ... running @ 150gpm

Twin "D" Stop	Twin "D" Start	Bressi Stop	Bressi Start
61 psi	56	170 psi (target 160)	146
1800 gpm	2100	700 gpm	1200
3500 gpm	3900		

1st call

2nd call

2010 Recycled Water Master Plan

Pressure Reducingt Stations

Measurement = Downstream(psi)/Upstream(psi)/Open(%)

Time Interval = 1:00

Date	Time	Faraday		10"	6"	La Coasta		18"	6"
Thur. 10/5/09	6:00 PM	83.4	154.6	0	1.2	102.0	166.0	~~2.0~~	3.0
	7:00 PM	83.2	153.8		0.6				
	8:00 PM	82.6	153.3		0.7				
	9:00 PM	81.3	151.5		.9				
	10:00 PM	79.8	147.3		.7				
	11:00 PM	80.0	142.5		1.6				
Fri. 10/6/09	12:00 AM	78.9	139.7		1.5				
	1:00 AM	79.2	142.4		1.3				
	2:00 AM	79.3	142.8		0				
	3:00 AM	80.5	139.7		.3				
	4:00 AM	78.7	143.7		3.6				
	5:00 AM	80.6	143.5		.3				
	6:00 AM	80.8	143.2		1.6				
	7:00 AM	80.8	146.5		.7				
	8:00 AM	81.7	147.6		.7				
	9:00 AM	81.6	147.4		1.7				
	10:00 AM	82.5	147.8		1.1				
	11:00 AM	82.7	147.8		1.1				
	12:00 PM	83.2	147.6	0	.5				
	1:00 PM	83.2	154.3	.5	1.2				
	2:00 PM	83.3	153.9	0	1.3				
	3:00 PM	83.3	154.2	0	1.2				
	4:00 PM	83.3	154.4	.4	1.2				
	5:00 PM	83.1	154.7	.1	1.7				
	6:00 PM	83.1	153.7	.5	1.6				
	7:00 PM	83.0	154.5	.5	.7				
	8:00 PM	82.6	153.9	0	2.1				
	9:00 PM	81.3	152.7	0	.8				
	10:00 PM	80.9	150.8	.4	1.0				
	11:00 PM	81.7	149.4	0	1.0				
Sat. 10/6/09	12:00 AM	81.8	145.4		.8				
	1:00 AM	81.8	144.1		.4				
	2:00 AM	81.5	144.0		1.4				
	3:00 AM	81.4	142.2		1.9				
	4:00 AM	80.8	144.4		1.4				
	5:00 AM	78.6	145.2		1.3				
	6:00 AM	79.2	145.6		3.7				
	7:00 AM	80.1	147.6		1.3				
	8:00 AM	80.8	147.8		.8				
	9:00 AM	80.9	148.1		1.2				
	10:00 AM	81.0	148.5		1.3				
	11:00 AM	81.9	148.4		1.3				
	12:00 PM	82.3	148.1		1.2				

spicks open very short time to 20%

2010 Recycled Water Master Plan

Pressure Reducingt Stations

Measurement = Downstream(psi)/Upstream(psi)/Open(%)

Time Interval = 1:00

Potable PRV

Date	Time	Avenida Encinas			Twin "D"		
Fri ~~Thur.~~ 10/15/09	6:00 PM	113.8	155.0	.7			
	7:00 PM	113.7	154.4	.7			
	8:00 PM	113.6	154.3	.7			
	9:00 PM	105.2	152.4	11.0			
	10:00 PM	105.0	151.5	10.5			
	11:00 PM	104.4	156.9	22.3			
Sat ~~Fri.~~ 10/16/09	12:00 AM	104.6	155.9	13.8			
	1:00 AM	113.8	155.9	.4			
	2:00 AM	105.4	156.6	5.6			
	3:00 AM	104.6	157.8	13.7			
	4:00 AM	104.6	156.8	13.2			
	5:00 AM	104.2	159.0	16.9			
	6:00 AM	104.6	155.2	12.1			
	7:00 AM	107.1	155.5	1.2			
	8:00 AM	106.2	155.7	.2			
	9:00 AM	113.7	156.2	.2			
	10:00 AM	113.7	156.9				
	11:00 AM	113.5	156.8				
	12:00 PM	113.5	157.2				
	1:00 PM	113.6	158.2				
	2:00 PM	113.5	157.3				
	3:00 PM	113.4	157.1				
	4:00 PM	113.3	156.1				
	5:00 PM	113.2	65.8				
	6:00 PM	113.0	154.8				
	7:00 PM	112.9	154.5				
	8:00 PM	109.4	153.7	17.9			
	9:00 PM	104.2	153.4	17.7			
	10:00 PM	104.3	152.4	15.4			
	11:00 PM	104.3	158	14.6			
Sun ~~Sat.~~ 10/17/09	12:00 AM	105.6	158.6	8.9			
	1:00 AM	104.5	159.9	14.9			
	2:00 AM	104.3	154.6	6.2			
	3:00 AM	104.2	153.6	20.4			
	4:00 AM	104.6	154.0	12.6			
	5:00 AM	104.1	152.9	18.6			
	6:00 AM	104.6	154.3	11.6			
	7:00 AM	109.4	154	0.5			
	8:00 AM	106.7	154	.5			
	9:00 AM	113.5	154	.5			
	10:00 AM	113.7	153.9				
	11:00 AM	113.6	155.5				
	12:00 PM	113.7	155.5				

never opens

2010 Recycled Water Master Plan

Flow Control Stations

Ralph Valve

Measurement = Flow(gpm/Open(%)

Time Interval = 1:00

Date	Time	Corinthia Flow	Corinthia open	Corinthia suct	Corinthia Dsh	~~Dump Valve~~ open/close
Thur. 10/15/09	6:00 PM	9.2	97.3	96.7	96.3	close
	7:00 PM	355.1		96.3	96.1	
	8:00 PM	810.7		96.1	95.7	
	9:00 PM	1557		95.5	95.0	
	10:00 PM	2610		94.4	93.6	
	11:00 PM	2811		90.8	90.0	
Fri. 10/16/09	12:00 AM	3571		91.8	90.9	Open
	1:00 AM	4360		92.1	90.8	
	2:00 AM	4290		92.6	91.3	
	3:00 AM	3780		87.9	86.8	
	4:00 AM	3990		91.3	90.2	
	5:00 AM	3750		91.8	90.9	
	6:00 AM	3209		90.1	89.2	
	7:00 AM	3372		93.6	92.6	
	8:00 AM	2969		93.9	93.1	
	9:00 AM	3003		93.8	93.0	
	10:00 AM	2909		94.1	93.2	
	11:00 AM	2872		93.6	33.0	
12:11 goes to 212 gpm	12:00 PM	2874		93.8	93.2	Close
	1:00 PM	13.5		96.3	96.2	
	2:00 PM	21.9		95.8	95.5	
	3:00 PM	12.7		96.2	95.8	
	4:00 PM	11.0		96.3	96.1	
	5:00 PM	9.2		96.9	96.6	
	6:00 PM	10.7		95.8	95.5	
	7:00 PM	30.5		96.5	96.4	
	8:00 PM	559.1		96.2	96.2	
	9:00 PM	854		95.8	95.4	
	10:00 PM	1246.9		94.9	94.6	
	11:00 PM	1600		94.2	93.8	
Sat. 10/17/09	12:00 AM	3712		93.9	93.0	open
	1:00 AM	3863		93.2	92.5	
	2:00 AM	3899		93.9	92.7	
	3:00 AM	3330		90.3	89.4	
	4:00 AM	3494		92.8	91.9	
	5:00 AM	3423		93.7	92.7	
	6:00 AM	2927		91.5	90.7	
	7:00 AM	3016		~~92.3~~ 93.9	93.4	
	8:00 AM	2923		94.1	93.4	
	9:00 AM	2967		94.1	93.5	
	10:00 AM	2956		94.1	93.6	
	11:00 AM	2835		94.0	93.6	
	12:00 PM	2872		94.4	93.6	close
	1:30 pm	8.3		97.2	96.8	

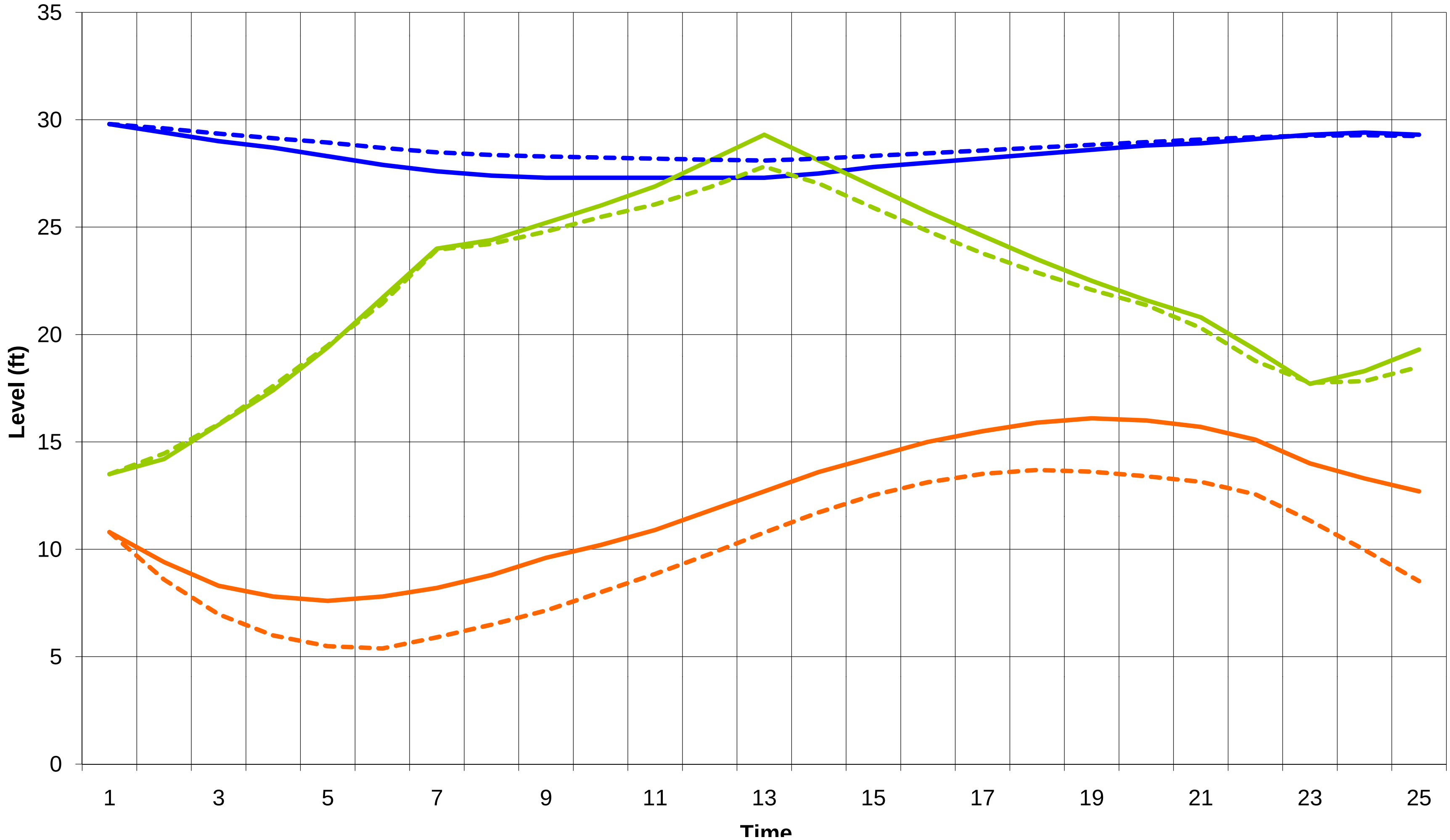
Water Quality Sampling Data Collection Form - Field Samples
Carlsbad Recycled Water Master Plan

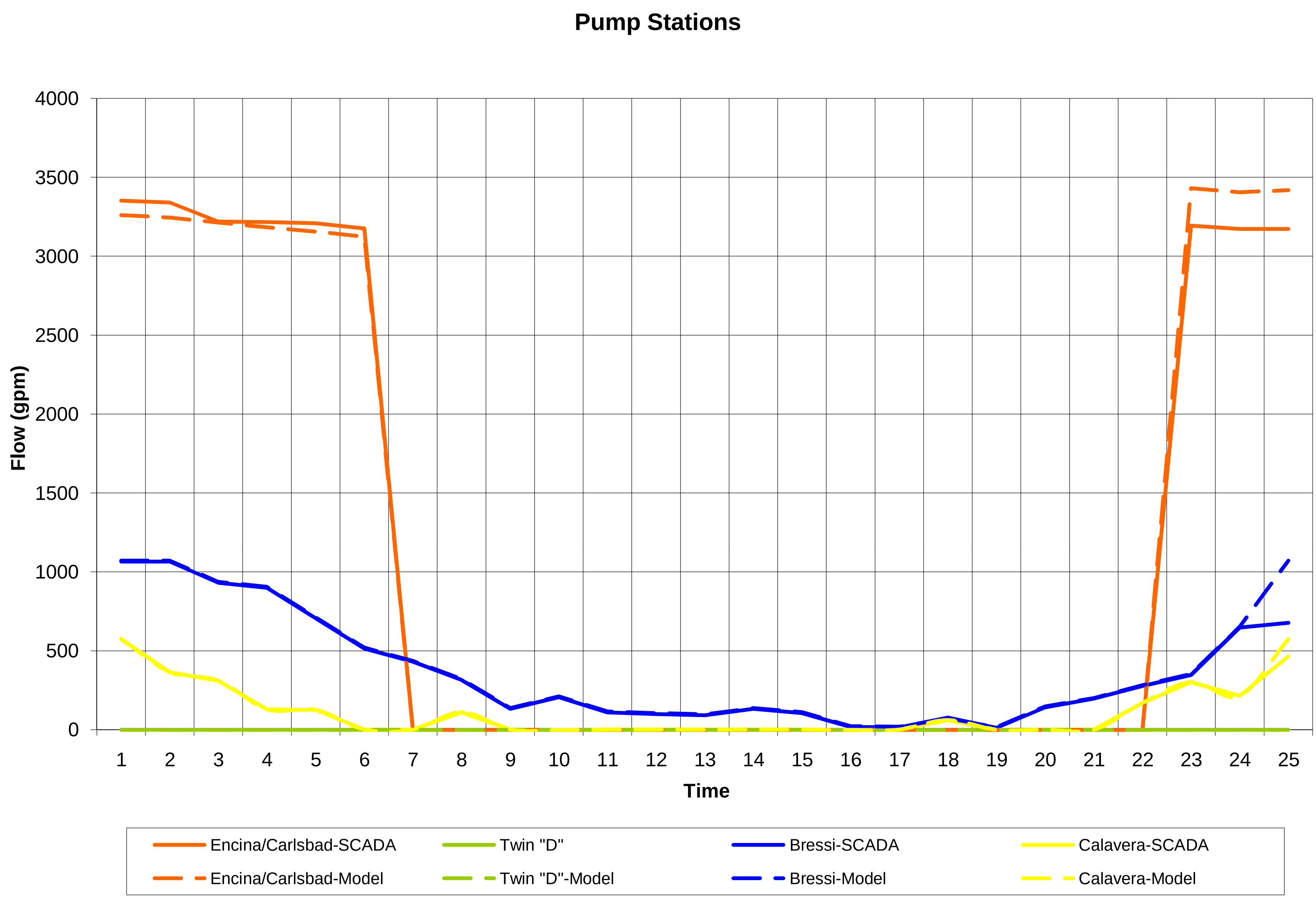
Site No.	Location/Figure	Date	Time	~~Free Chlorine (mg/L)~~	Total Chlorine (mg/L)	Comments
A	Figure 1a - Tamarack west of Cay	10/14/09	0900		Ø	
B	Figure 1a - Along Transmission Pipe from C Tank	"	0925		Ø	
C	Figure 1b - Cannon just northeast of Faraday	"	0935		0.2	
D	Figure 1d - Faraday and Priestly	"	0947		0.2	
E	Figure 1e - Melrose, between Palomar Airport and Lionshead	"	1000		5.5	
F	Figure 1f - Aviara, between Ambrosia and Mimosa	"	1013		1.1	
G	Figure 1k - Melrose and Camino Michelle	"				Nothing available to sample
H	Figure 1c - The Crossings, just south of Grand Pacific, north of Palomar Airport Rd	"	1137		2.0	
I	Figure 1h - At D-Tank	"	1108		3.0	
J	Figure 1h - Intersection of Avenida Encinas and Embarcadero	"	1125		3.9	
K	Figure 1k - Along Transmission of Mahr Reservoir	"	1052		4.2	Melrose N. of Alga

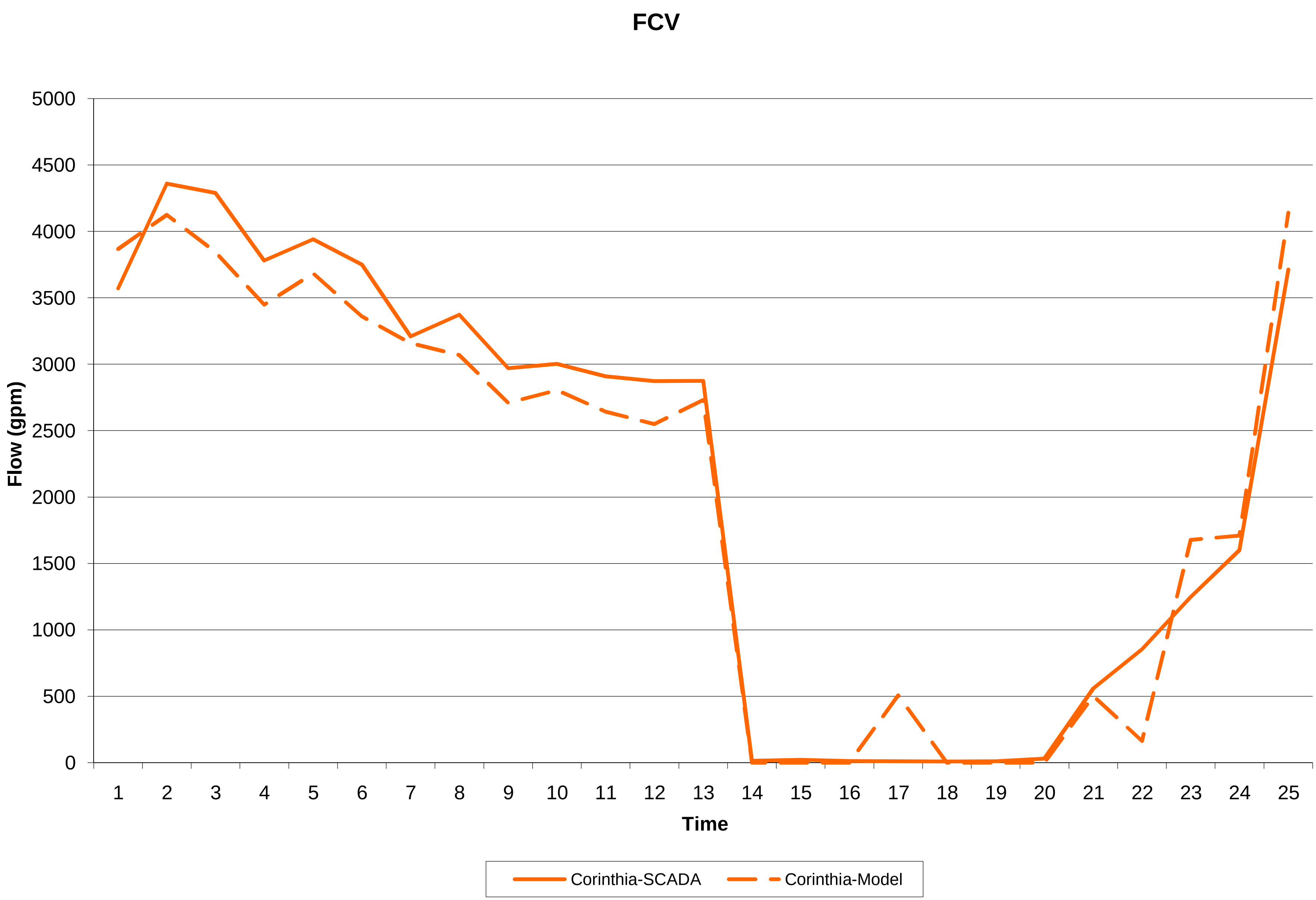
Additional Notes

Corintia west of Melrose 3.0T 1025

Reservoirs




Pump Stations
Flow (gpm)
4000
3500
3000
2500
2000
1500
1000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Time
Encina/Carlsbad-SCADA
Encina/Carlsbad-Model
Twin "D"
Twin "D"-Model
Bressi-SCADA
Bressi-Model
Calavera-SCADA
Calavera-Model


FCV
Flow (gpm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Time
Corinthia-SCADA
Corinthia-Model

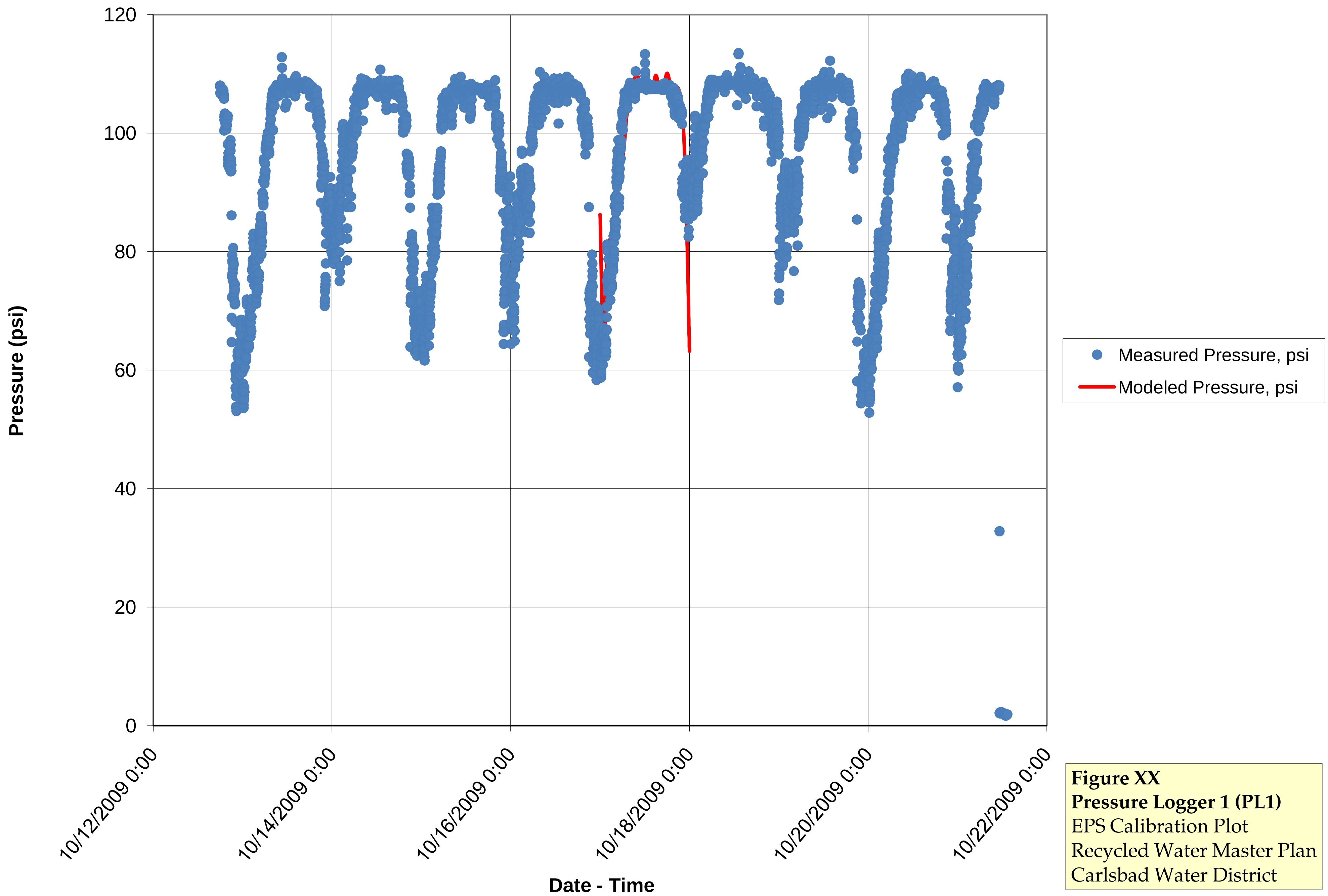


Figure XX
Pressure Logger 1 (PL1)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

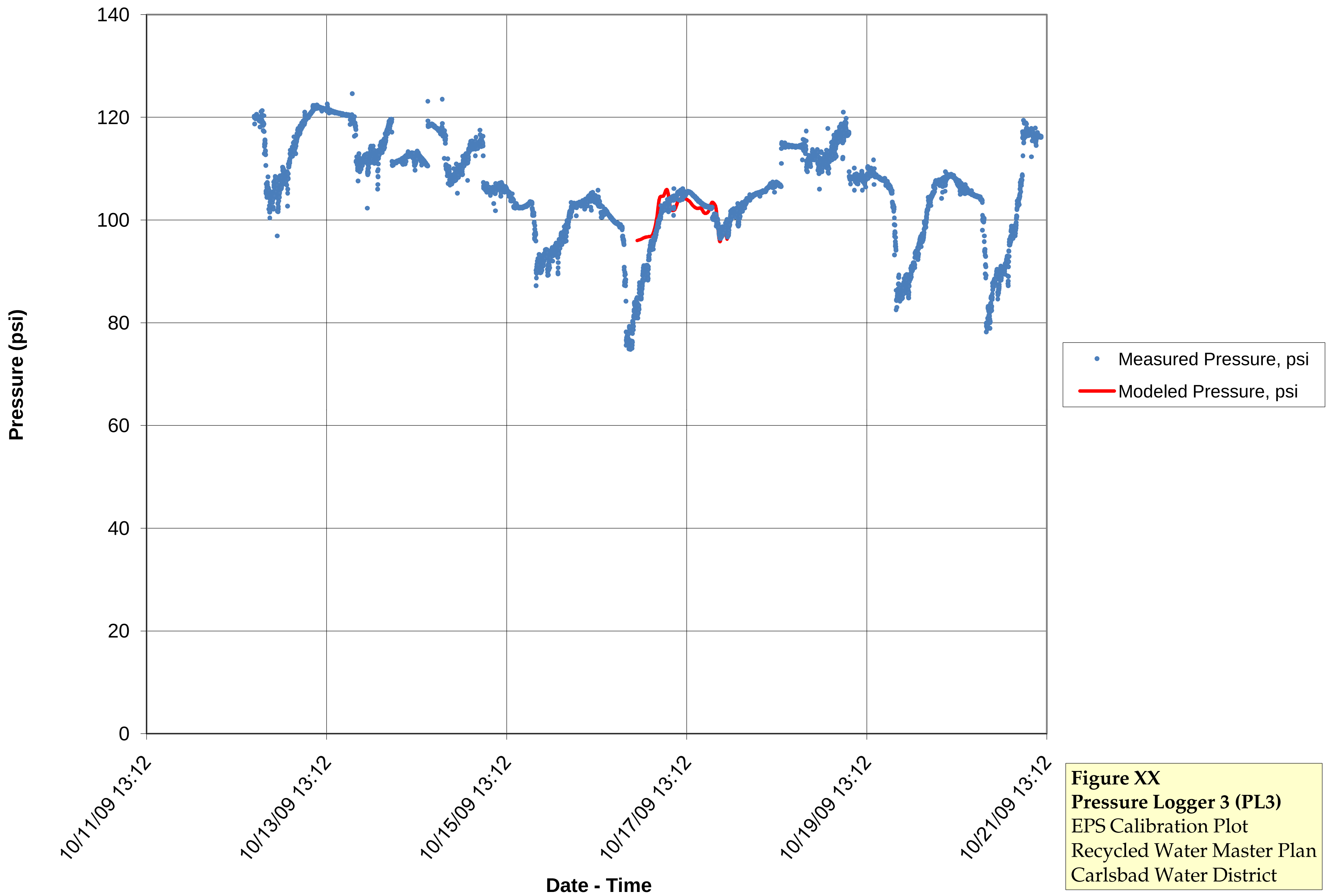


Figure XX
Pressure Logger 3 (PL3)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

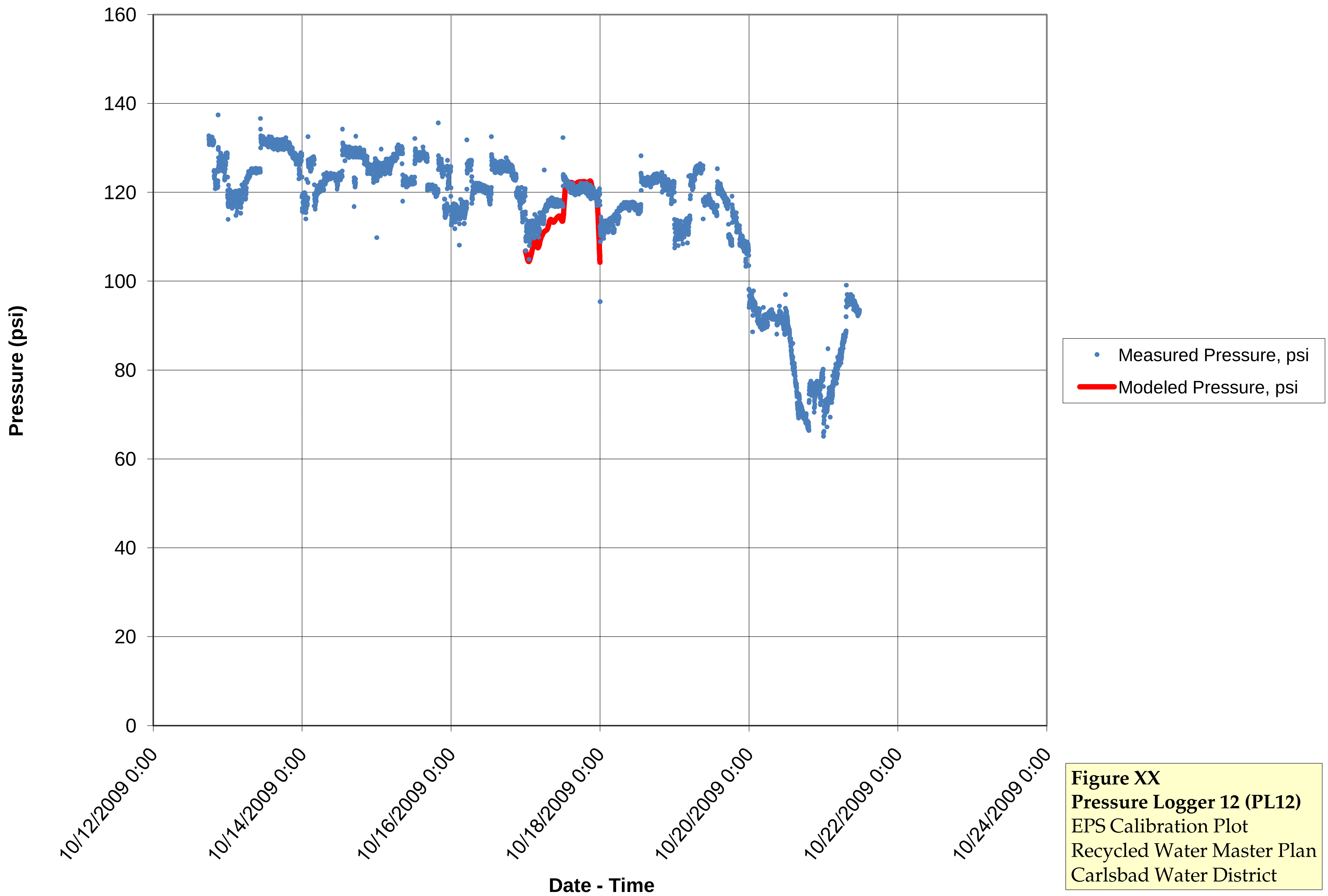


Figure XX
Pressure Logger 12 (PL12)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

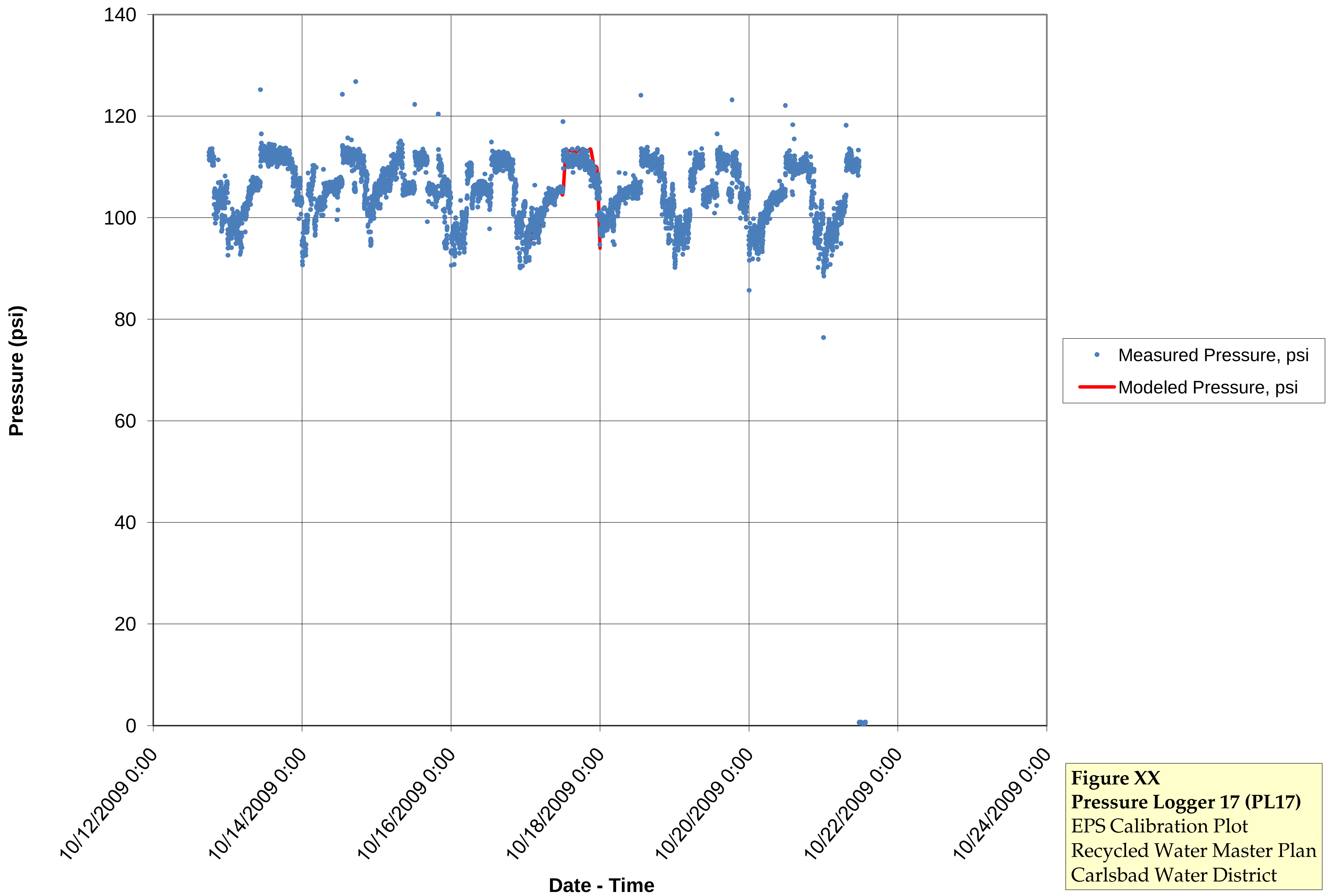


Figure XX
Pressure Logger 17 (PL17)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

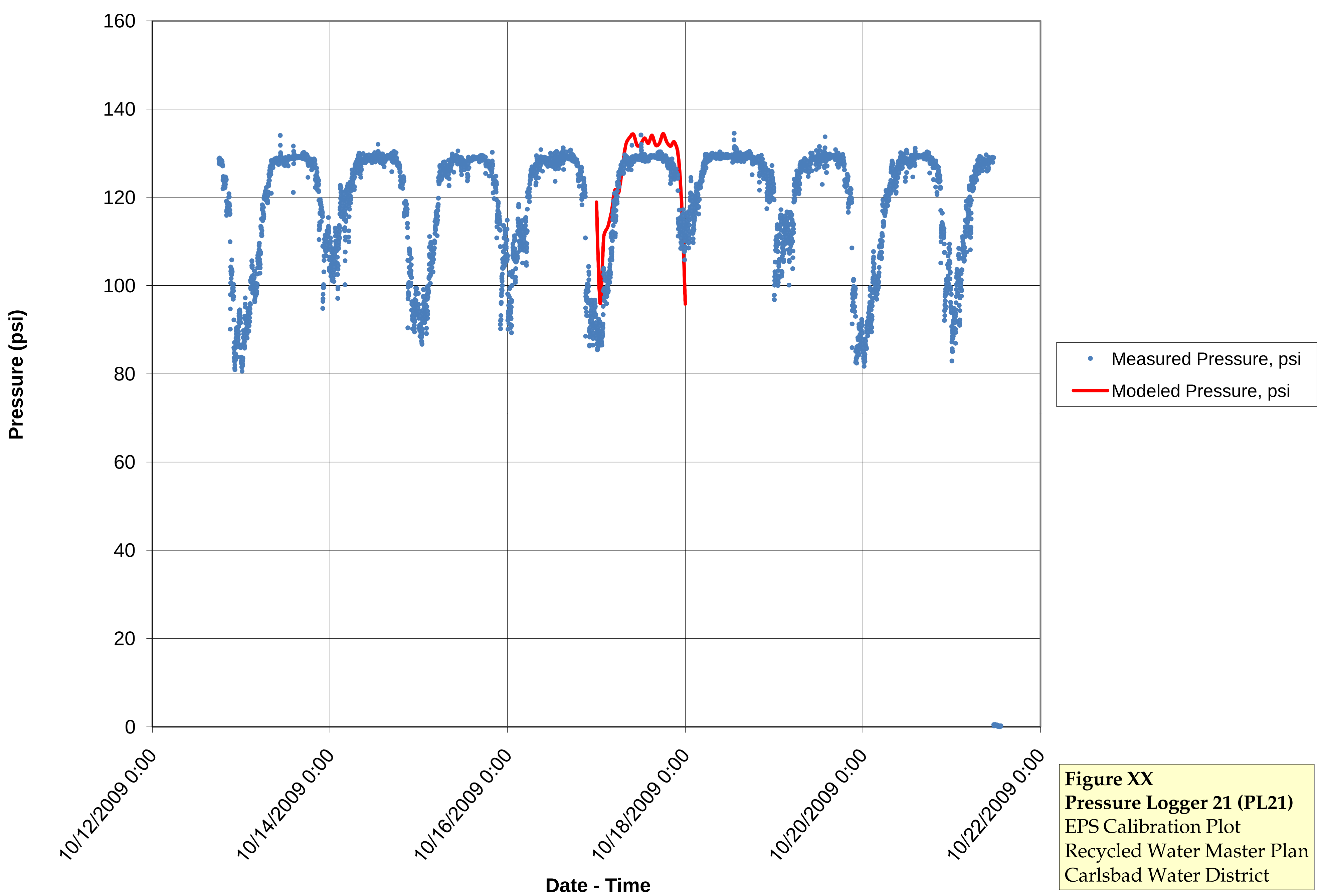


Figure XX
Pressure Logger 21 (PL21)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

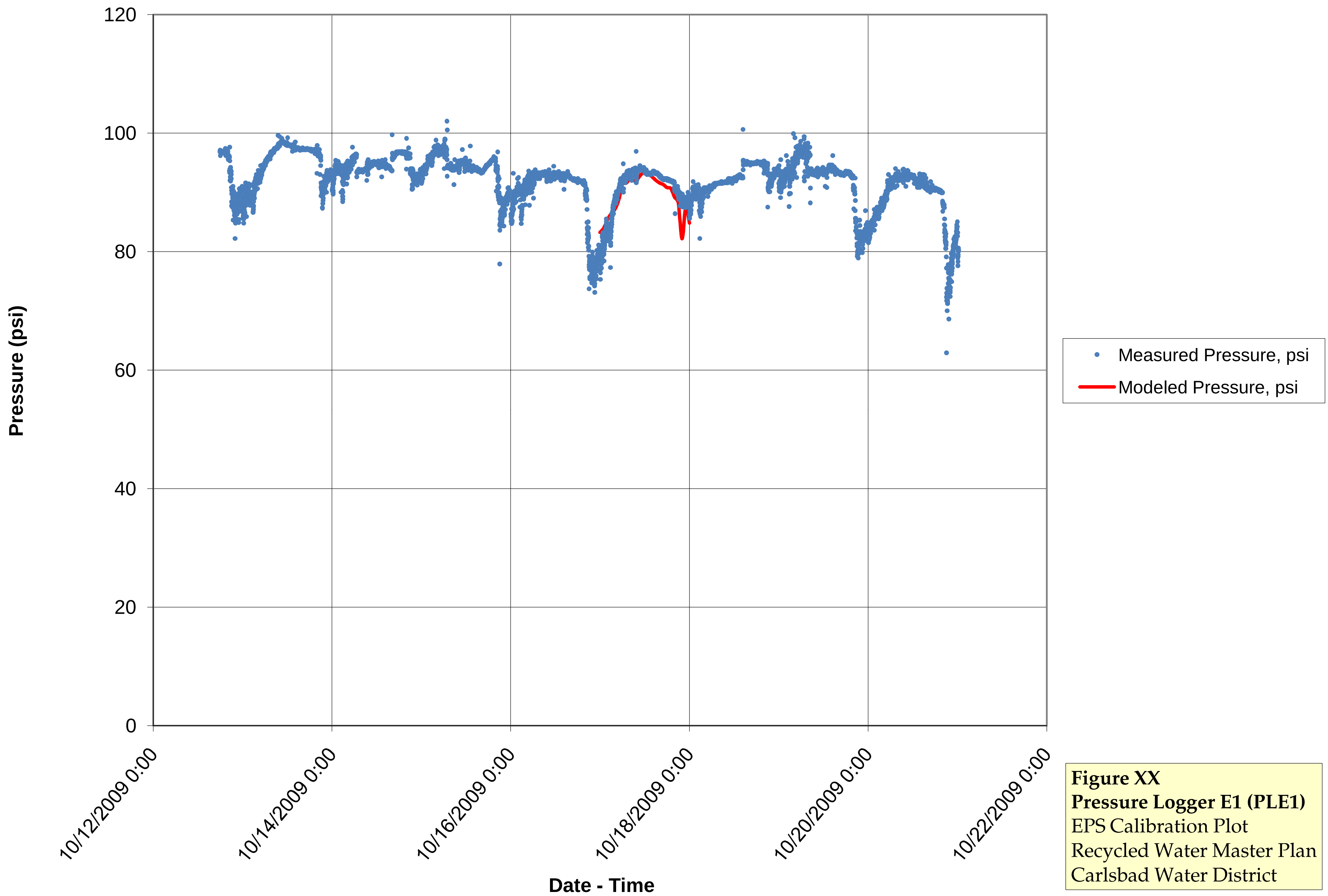


Figure XX
Pressure Logger E1 (PLE1)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

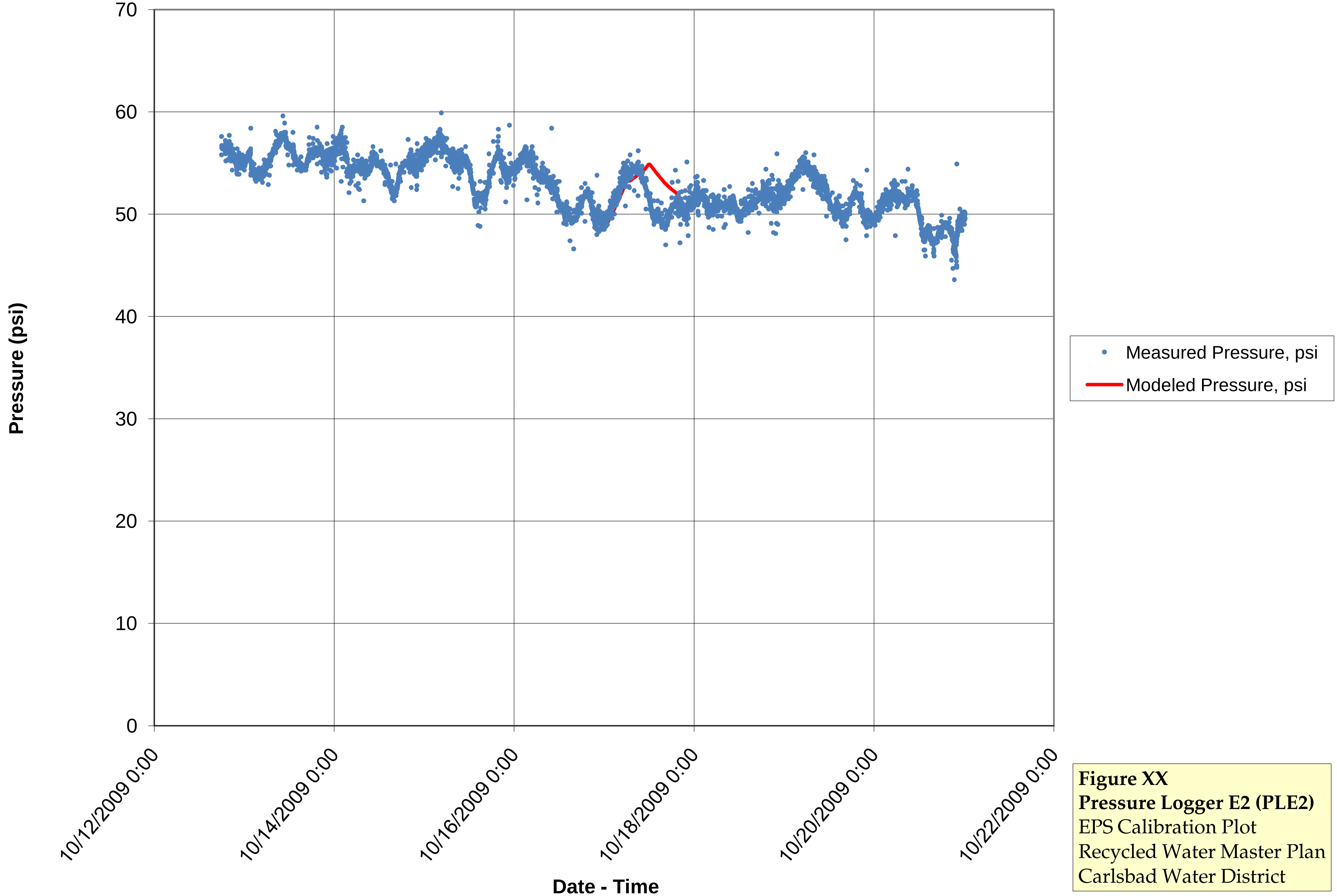


Figure XX
Pressure Logger E2 (PLE2)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

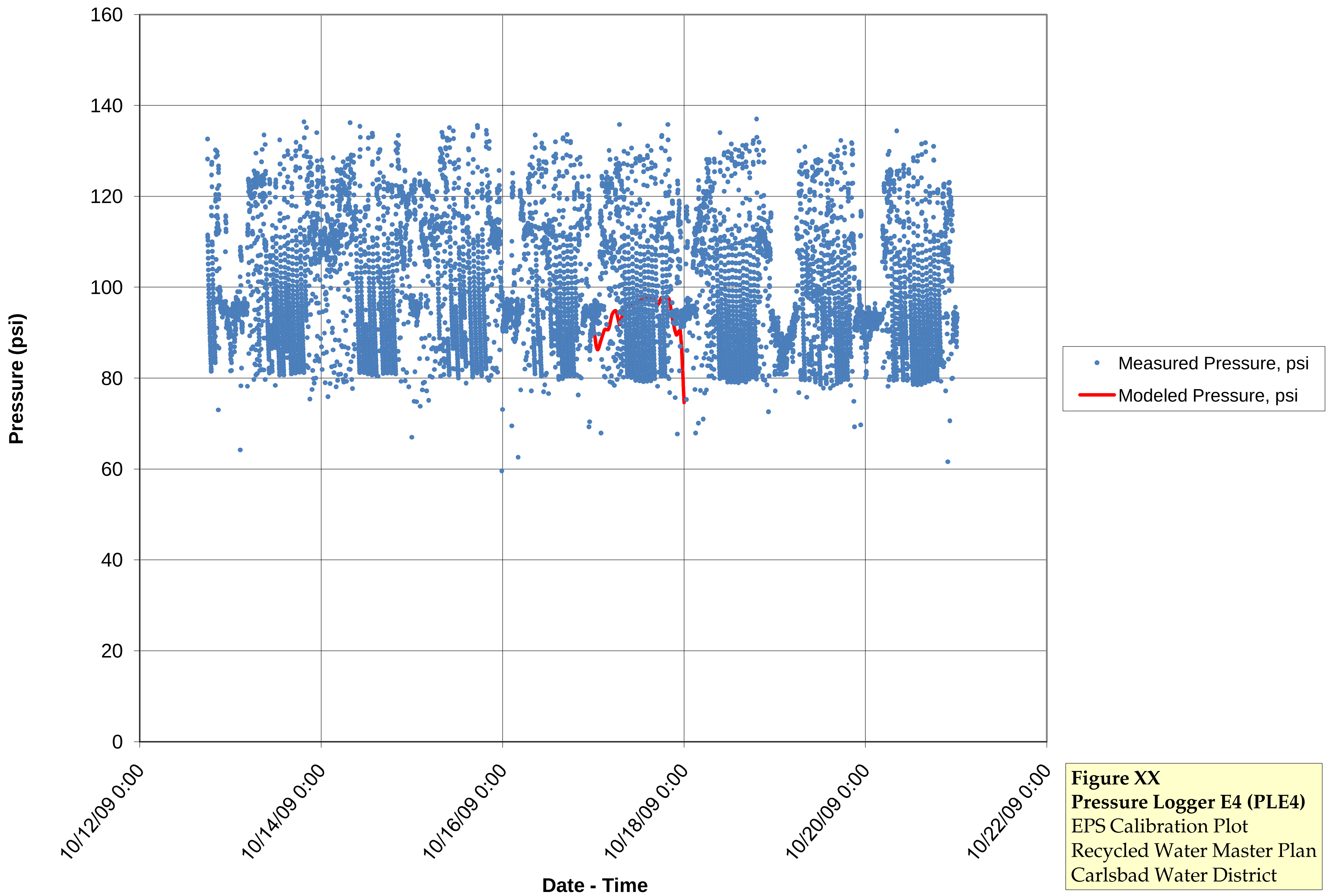


Figure XX
Pressure Logger E4 (PLE4)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

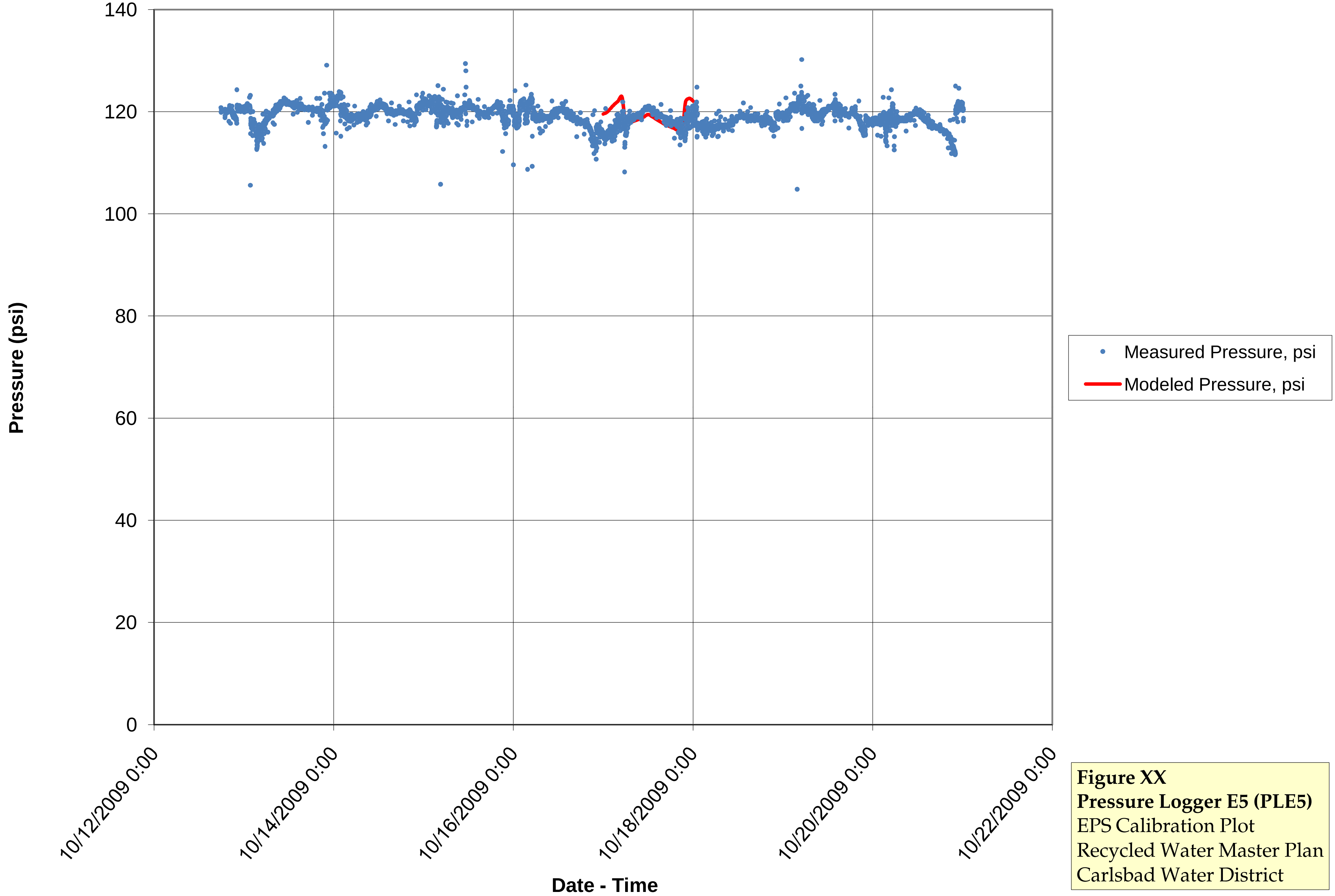


Figure XX
Pressure Logger E5 (PLE5)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

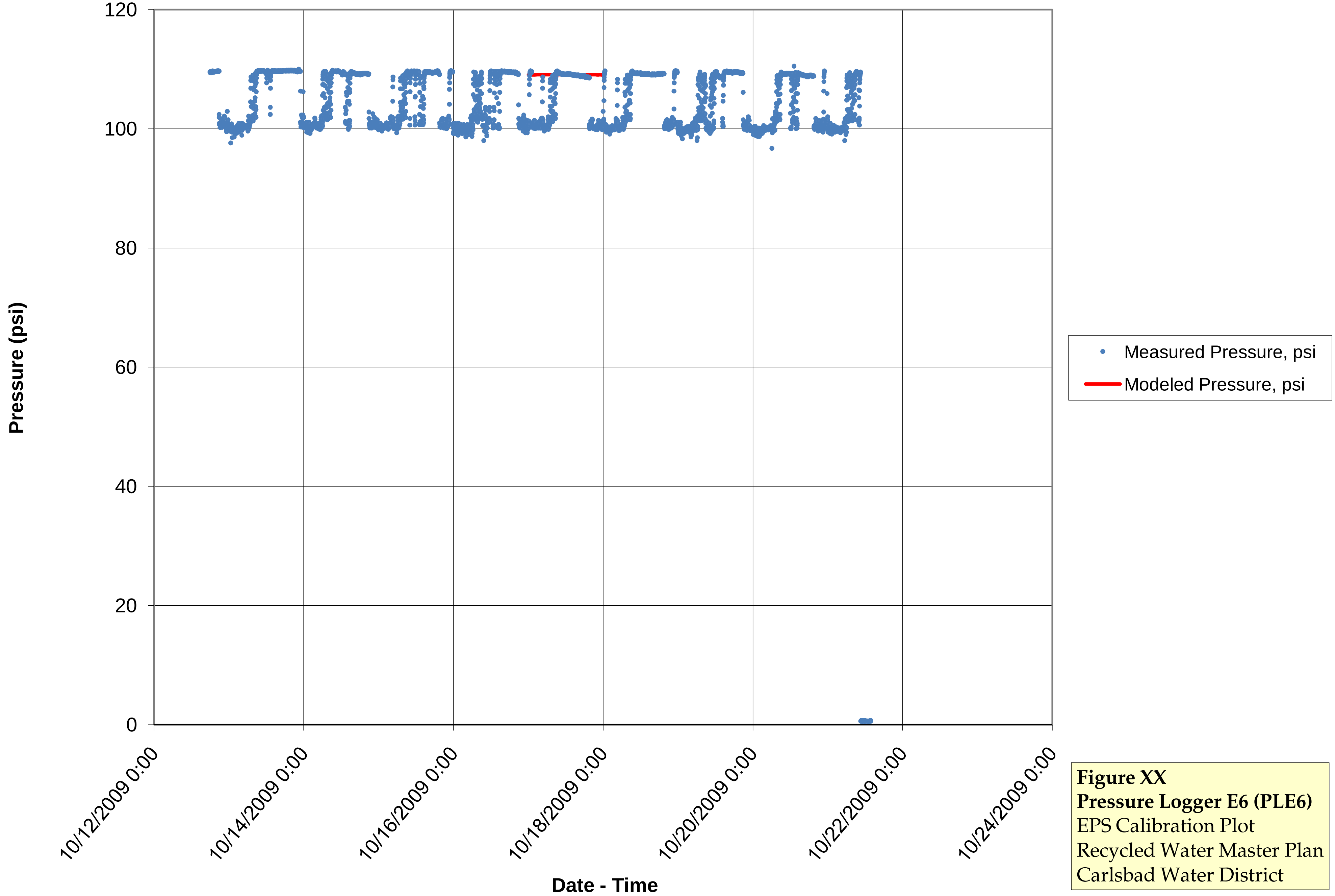


Figure XX
Pressure Logger E6 (PLE6)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

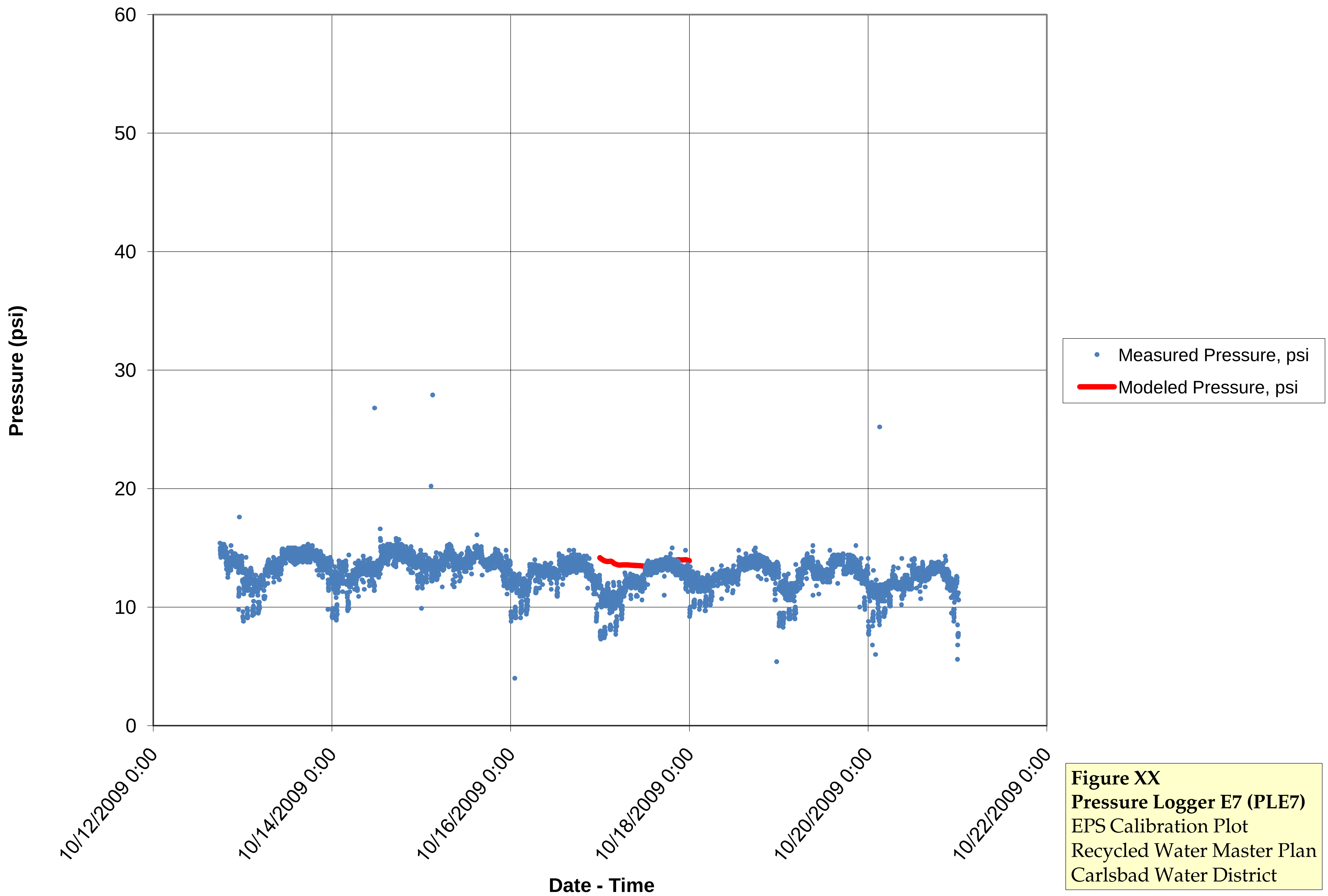


Figure XX
Pressure Logger E7 (PLE7)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

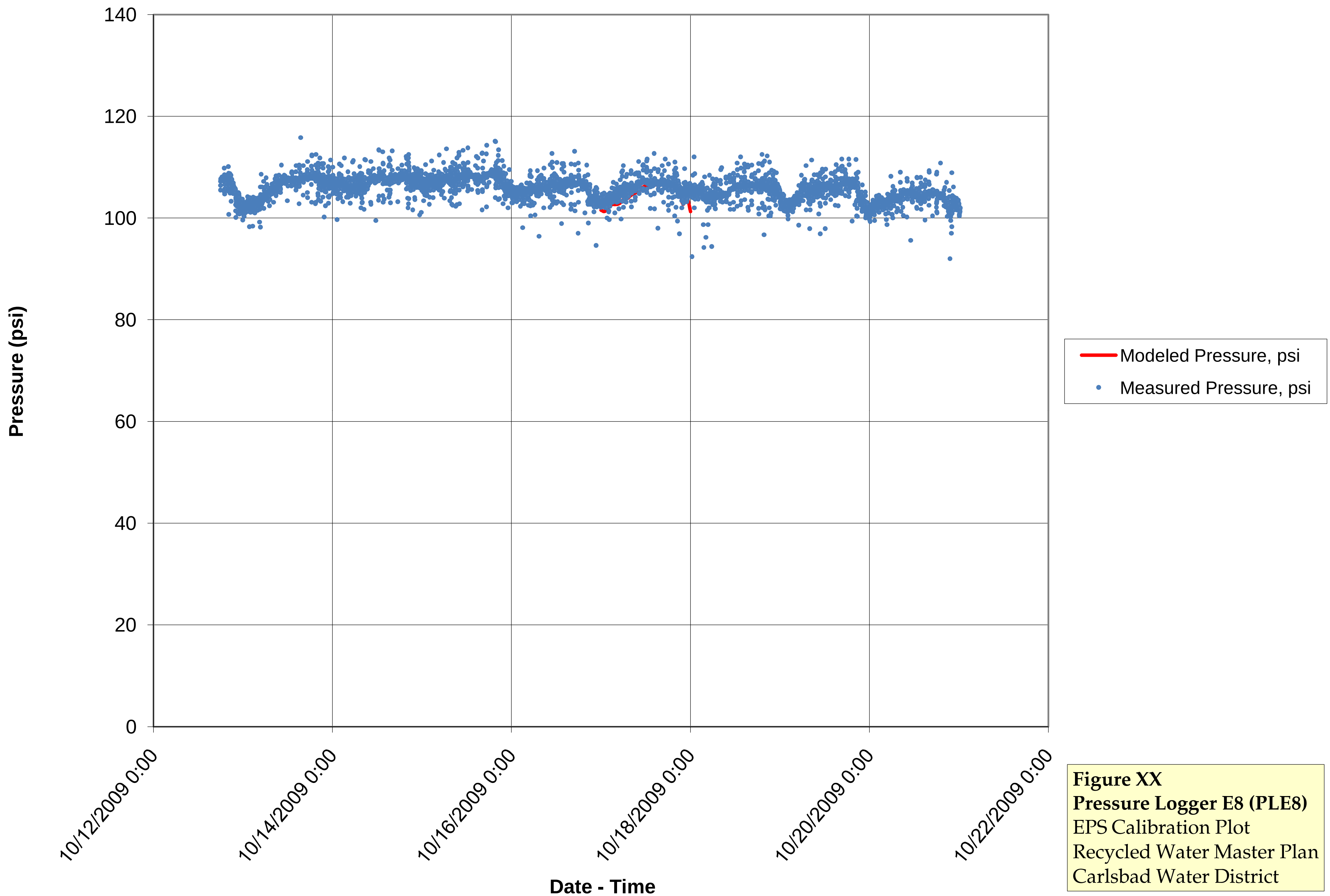


Figure XX
Pressure Logger E8 (PLE8)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

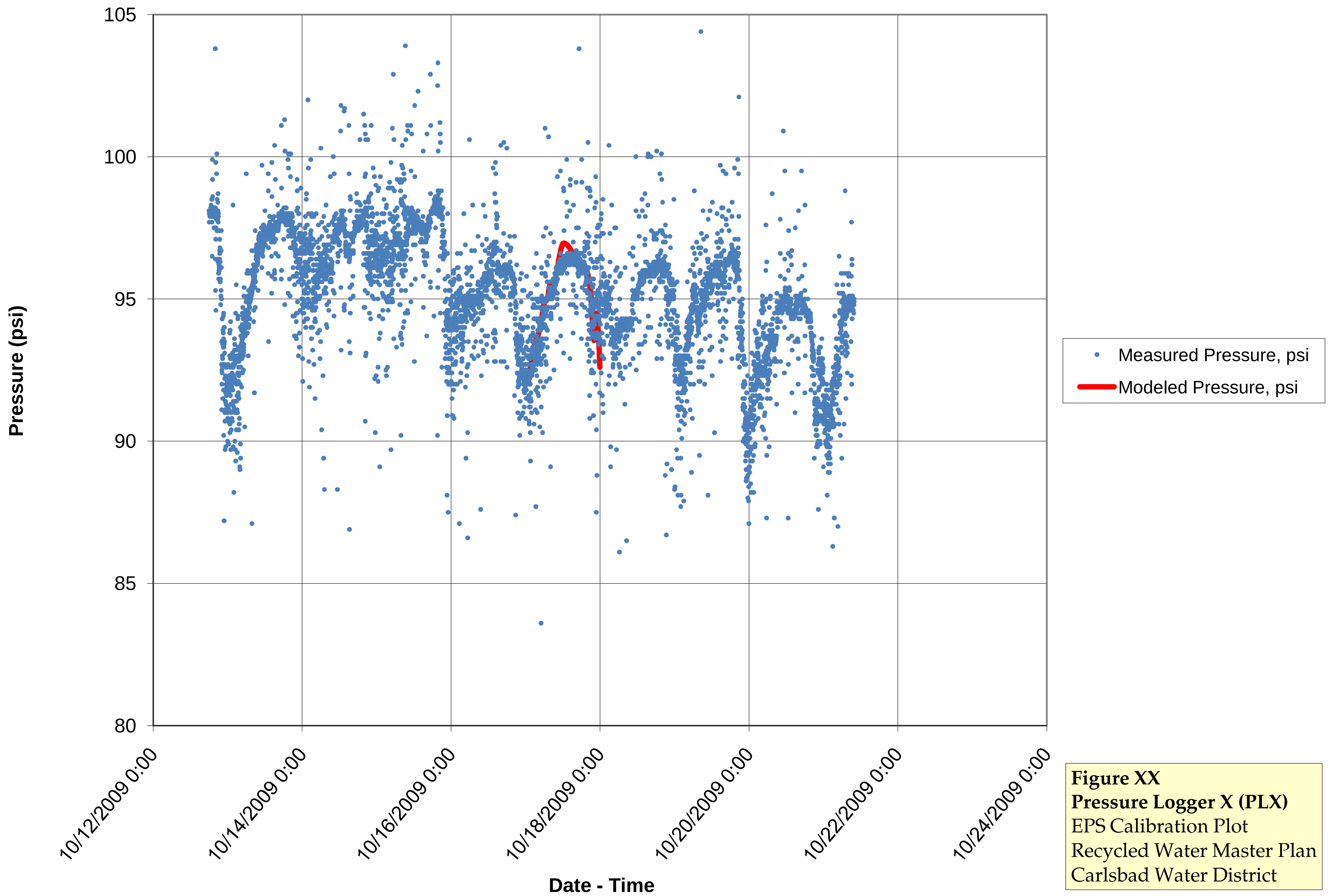


Figure XX
Pressure Logger X (PLX)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

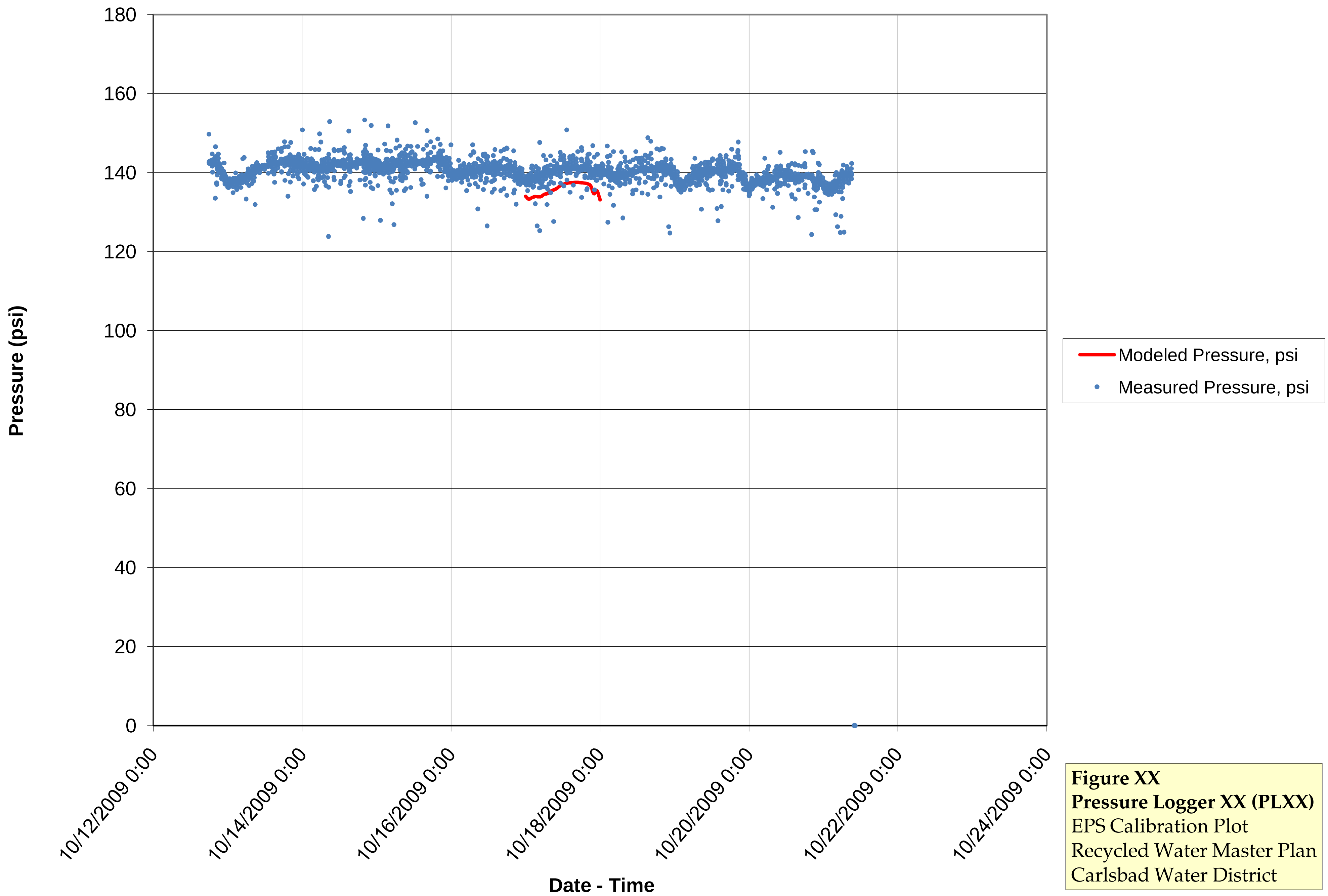


Figure XX
Pressure Logger XX (PLXX)
EPS Calibration Plot
Recycled Water Master Plan
Carlsbad Water District

HYDRAULIC MODEL MANUAL

This manual is intended as a reference for the District in utilization of the hydraulic model prepared as a part of the Carlsbad Recycled Water Master Plan. This manual pulls extensively from materials prepared as a part of the master plan, especially the model development chapter (Chapter 6). For further details on the calibration efforts, refer to Chapter 6 of the master plan.

G.1 HYDRAULIC MODEL OVERVIEW

Rapid innovations in personal computing and the large selection of software have made network analysis modeling efficient and practical for virtually any water system. Hydraulic modeling is an important tool for analyzing a water system. Hydraulic models can simulate existing and future water systems, identify system deficiencies, analyze impacts from increased demands, and evaluate the effectiveness of proposed system improvements, including those within capital improvement plans. In addition, a hydraulic model provides both the engineer and water system operator with a better understanding of the water system. Hydraulic models are typically composed of three main parts:

- The data file that stores the geographic location of facilities. The geographic data file provides water system facility locations and is typically represented as an AutoCAD or geographic information systems (GIS) file. Elements used in this file to model system facilities include pipes, junction nodes (connection points for pipes and location of demands), control valves, pumps, tanks, and reservoirs.
- A database that defines the physical system. The database for the District's model is linked to the geographic data file. The database includes water system facility information such as facility size and geometry, operational characteristics, and production/consumption data.
- A computer program "calculator". This calculator solves a series of hydraulic equations based on information in the database file to define and generate the performance of the water system in terms of pressure, flow and operation status.

The key to maximizing benefits from the hydraulic model is correctly interpreting the results so the user understands how the water distribution system is affected by the various components of the model. This understanding enables the engineer to be proactive in developing solutions to existing and future water system goals and objectives. With this approach, the hydraulic model is not only used to identify the adequacy of system performance, but is also used to find solutions for operating the water system according to established performance criteria.

Developing an accurate and reliable computer model begins with entering the best available information into the database and calibrating the model to match existing conditions in the field. Once the model has been calibrated, it becomes a valuable tool to evaluate operational problems and to plan distribution system improvement projects.

G.2 HYDRAULIC MODEL DEVELOPMENT

G.2.1 Hydraulic Model Selection

Several software programs are widely used to model distribution systems. The variety of program capabilities and features makes the selection of a particular software program generally dependent upon three factors: user preference, the requirements of the particular water distribution system, and the cost associated with the software.

The District has selected H_2OMAP® Water, developed by MWH Soft, Inc., for the hydraulic modeling of its recycled water distribution system.

G.2.2 Previous Hydraulic Model

The District's initial hydraulic model of its recycled water distribution system was developed in 2000 as a part of the Encina Basin Recycled Water Distribution System Study (JPA, 2000) using H_2ONET® Version 2.0.

The hydraulic model provided to Carollo Engineers at the beginning of this project was developed by District staff in H_2OMAP® Water.

G.2.3 Hydraulic Model Creation

The District provided GIS layers containing relevant information concerning its pipeline network. Since the level of detail and topology of the District's GIS layers was judged to be more representative of the recycled water distribution system than the previous hydraulic model, the District's GIS layers were imported into the hydraulic model rather than the pipelines from the previous hydraulic model. Facilities and controls were then adapted from the previous hydraulic model. In summary, the model creation process involved the following steps:

- Link Creation. Links were created from the District's GIS layers of pipeline elements to represent the District's recycled water system.
- Node Creation. Nodes were automatically generated at the intersections of pipeline segments. Individual nodes representing specific components of the City's recycled water system such as tanks and reservoirs were added.
- Attribute Data Input. Unique attribute data was assigned to each link and node.
- Facility Creation. Facilities were imported from the previous hydraulic model and verified through discussions with District staff.
- Operational Data. Based on the previous hydraulic model as well as discussions with District operations staff, control parameters were assigned to the appropriate links and nodes.

The model operates according to the operational and physical attributes assigned to each node and link. This information is used to simulate flows and pressures within the system as predicted by the model's mathematical equations. A screenshot of the hydraulic model is shown in **Figure G.1**.

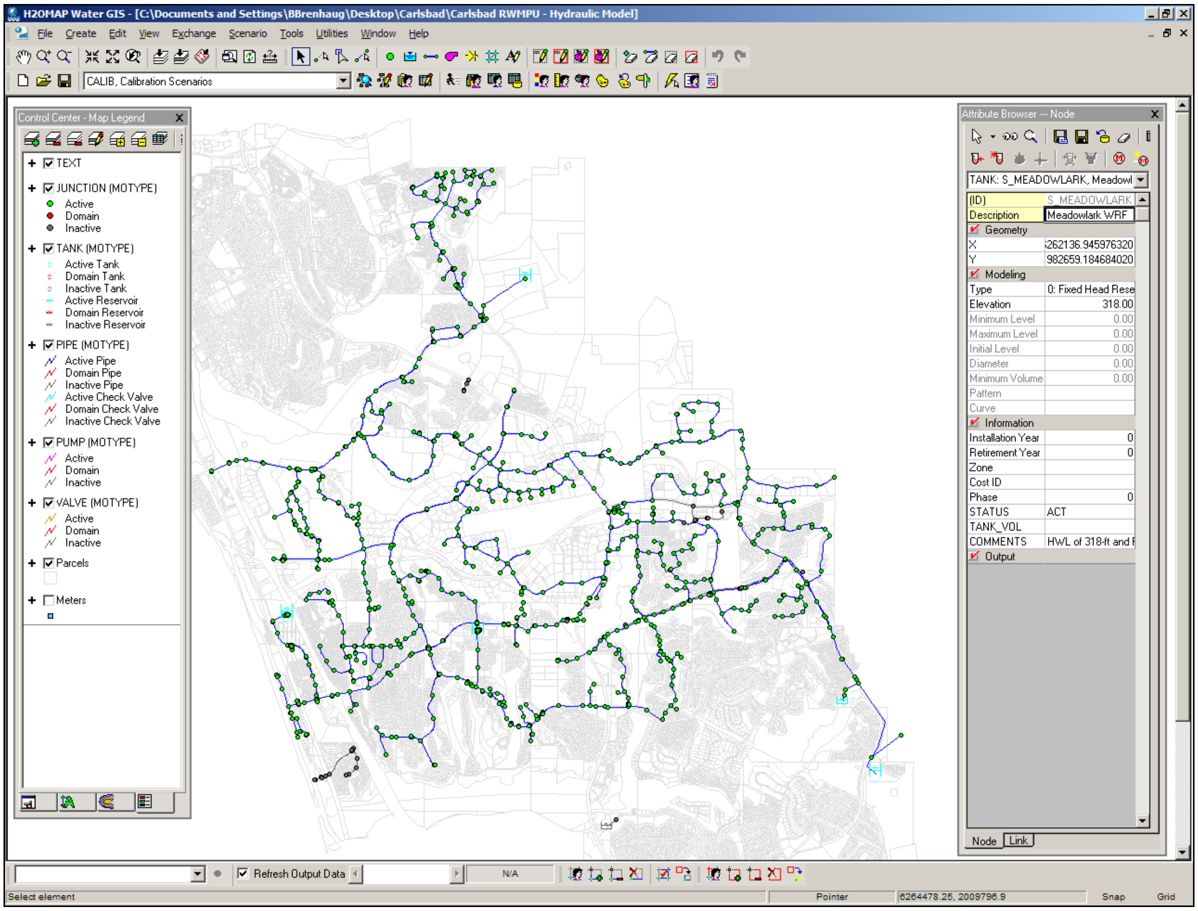


Figure G.1 Screenshot of Hydraulic Model

G.2.4 Model Pipelines

Hydraulic models consist of links and nodes to model representations of physical system components of a distribution system. Links are used to represent pipes, pumps, and control valves. Pipeline segments represent the actual transmission or distribution water pipelines. In the attribute table for each pipe, data typically includes diameter, length, C-factor, and pressure zone. The model calculator uses the attribute data to determine increases or decreases in energy levels across the link. Some of the reported output data which the model calculates for links include flows, velocities, head loss, and changes in hydraulic grade line.

G.2.5 Model Nodes

Nodes represent the connections between links and may act as either a supply source, such as a reservoir or tank, or a customer demand. Nodes also define the boundaries of each link and separate links that may contain different attributes. Each node also has an elevation that fixes the elevations of the connecting link elements. Attribute data associated with each node typically includes elevation, water demand, and pressure zone. The model calculates system pressures, hydraulic grade lines, demands, and water quality parameters at each node.

G.2.6 Demand Allocation

For the existing system, demands were allocated based on historical billing records for the calendar year 2008. Demands from customer meters were allocated to the existing junction within the hydraulic model nearest the location of the meter in the City's GIS layer of meters.

Locations of meters for the five largest users were imported directly from the City's GIS layer of meters, giving the five largest users their own nodes. These meters are assigned the same Meter ID as the City's GIS layer and the name of the customer is included in the Description field for the junction element.

For the future system, demands from the customer database were allocated to the nearest junction …

G.2.7 Elevation Allocation

Elevations were linearly interpolated to all junctions from the City's GIS layer of ground elevation contours. This contour layer has 2-foot intervals and according to the filename reflects topography in 2005.

As a part of model development during calibration, elevations were adjusted in the vicinity of Whiptail Loop north of Faraday Avenue to reflect grading changes made after 2005.

For pipeline segments extending outside the coverage of the elevation contours provided by the District, approximate elevations were calculated from data obtained from USGS (USGS, 2010).

G.3 SCENARIOS

Table G.1 Scenarios
Recycled Water Master Plan
Carlsbad Municipal Water District

Scenario Name	Description	Intent	Comment
BASE	Base Network Scenario	Not for Use	
CALIB	Calibration Scenarios	Calibration	Use Time Setting: CALIB_024HRS
EXIST	Existing Scenarios	Existing System	
FUTURE	Future Scenarios	Not for Use	
FUTURE_ALGN	Future Alignments Analysis	Expansion Segments	
FUTURE_ALT	Future Alternative Expansion Analysis	Alternatives (e.g., TAP Connection)	
FUTURE_ULT	Future Ultimate Analysis	Build Out	

G.4 DEMANDS

G.4.1 Demand Conditions

Rather than using separate demand sets for the various demand conditions, the model is set up to utilize the demand multiplier as the seasonal peaking factor for different demand conditions.

The advantage of this method is that when adding a new demand to the existing system, it is only necessary to add it to the active demand set; it is not necessary to replicate it in multiple demand sets for Maximum Month Demands, Average Day Demands, etc. The primary disadvantage is that a single seasonal peaking factor is used for all customers.

To change the current demand condition, choose the desired demand condition from the list of Simulation Options in the Run Manager.

Table G.2 Demand Conditions Recycled Water Master Plan Carlsbad Municipal Water District		
Simulation Options ID	**Description of Demand Condition**	**Seasonal Peaking Factor**
AAD_WQ	Average Annual Demand	1.0
MMD	Maximum Month Demand	1.7
NDD	Minimum Month Demand	0.2

The above seasonal peaking factor is entered into the Global Demand Multiplier dialog box of the Demand tab in Simulation Options for each demand condition.

G.4.2 Demand Sets

Demand sets are used to model different scenarios for the distribution system. For example, the future system includes customers that are not represented in the existing system. Within H_2OMAP® Water, scenarios are assigned a Demand Set, corresponding to a specific demand condition.

The model includes five demand sets, details of which are shown in Table G.3.

Table G.3 Demand Sets Recycled Water Master Plan Carlsbad Municipal Water District	
Demand Set ID	**Intended Use**
BASE	Not for Use
CALIB	Replication of Calibration Scenario
EXIST_ADD	Average Day Demand
FUTURE_ADD	Future System (All Expansions Included, but no Ultimate Demands)
ULTIMATE_ADD	Ultimate Demands (no temporary agricultural demands)

The above seasonal peaking factor is entered into the Global Demand Multiplier dialog box of the Demand tab in Simulation Options for each demand condition.

G.4.3 Demand Tables

Within $H_2OMAP^{®}$ Water, each Demand Set consists of a demand table containing nine fields of demands assigned to each junction, named Demand1 through Demand9. Each field can represent a component of demand. For the calibration and existing scenarios, the demand tables use only the Demand1 field. For the future system demand sets, the fields Demand1 through Demand3 are used to clarify the inclusion or relevancy of demands.

Table G.4 Demand Table Fields
Recycled Water Master Plan
Carlsbad Municipal Water District

Field Name	Demand Source
Demand1	Existing System Demands
Demand2	Potential Customers (from Customer Database)
Demand3	New Development Areas (with indefinite timing)

It is recommended that when testing alternatives in the existing system Demand2 through Demand9 are used to avoid unintentionally adding demands into the existing system database.

G.5 FACILITIES

Table G.5 describes how each of the District's facilities are modeled in the existing and future systems.

Table G.5 Modeling of Facilities
Recycled Water Master Plan
Carlsbad Municipal Water District

Facility	Facility Type	Modeled As	Notes
Carlsbad WRF	Discharge Pump Station	Pumps (3)	Two additional pumps in Future scenarios
Carlsbad WRF	Equalization Basin	Cylindrical Tank (Equivalent)	Additional equalization basin is in the model but inactive for future scenarios.
Avenida Encinas PRV	Pressure Regulating Station	Valves (2-PRVs)	
Twin D	Booster Pump Station	Pumps (4)	One is off due to firm capacity.
Twin D	Ralph Valve	Valve (PSV)	

Table G.5 Modeling of Facilities
Recycled Water Master Plan
Carlsbad Municipal Water District

Facility	Facility Type	Modeled As	Notes
Twin D	Potable Makeup Connection	Not Modeled	Not Modeled
Twin D	Reservoir	Cylindrical Tank (Equivalent)	
C Tank	Reservoir	Cylindrical Tank	
La Costa / Poinsetta PRV	Pressure Regulating Station	Valves (2-PRVs, 1-Relief)	
Corintia Valve	Isolation Valve	Valve (1-TCV)	
Mahr	Reservoir	Tank (Variable Area)	
Bressi PS	Pump Station	Pumps (3)	Includes hydropneumatic tank
Faraday PRV	Pressure Regulating Station	Valves (2-PRVs, 1-Relief)	
Meadowlark WRF	Discharge Pump Station	Pumps (3)	Not modeled in Existing and Calibration Scenarios
Meadowlark WRF	Clearwell	Cylindrical Tank (Equivalent)	Not modeled in Existing and Calibration Scenarios
Calavera PS	Pump Station	Pumps (3)	Includes hydropneumatic tank
Village PS	Pump Station	Pumps (2)	Modeled as VSP; one is off due to firm capacity.
Carlsbad WRF Low Pressure PS	Discharge Pump Station	Pumps (2)	Modeled as VSP; one is off due to firm capacity.
Holly Springs HOA PS	Pump Station	Pumps (3)	Includes hydropneumatic tank
VID PS	Pump Station	Pump (1)	Modeled as VSP.
Salk PRS	Pressure Regulating Station	Valve (1-PRV)	
Cannon PRS	Pressure Regulating Station	Valve (1-PRV)	
Quarry Creek PRS	Pressure Regulating Station	Valve (1-PRV)	
La Costa Ridge PS	Pump Station	Pumps (2)	Modeled as VSP; one is off due to firm capacity.
Santa Fe Tank I	Reservoir	Cylindrical Tank	
Zone 550 Tank	Reservoir	Cylindrical Tank	

G.6 DATABASE FIELDS

G.6.1 Attribute Data Information

For junction elements, attribute data was added for the fields DMD_NODE, FACILITYID, FAC_NODE, LARGEUSER, STATUS, LOGGER, and LOGGERID. The LOGGER and LOGGERID fields were added as a part of the calibration process. Descriptions for the junction fields added to the model as well as sources are shown in Table G.6.

For pipeline elements, attribute data was imported from the City's GIS pipeline layer for the fields Diameter, Material, Zone, Year of Installation, and Facility ID. Descriptions for all the fields added to the pipeline elements in the model as well as sources are shown in Table G.7.

Table G.6 Junction Attribute Data Fields
Recycled Water Master Plan
Carlsbad Municipal Water District

Field Name	Description	Valid Entries	Source
DMD_NODE	Indicates if a demand is placed on the junction.	Boolean (Yes or No)	Demand Allocation
FAC_NODE	Indicates if the junction is a part of a facility.	Boolean (Yes or No)	Generated by Consultant
LARGEUSER	Indicates if the junction represents the meter of a large user.	Boolean (Yes or No)	City's meter GIS layer.
STATUS	Indicates whether a facility is active in the existing system.	ACT, ABAN	City's pipeline GIS layer: "STATUS" Field

Table G.7 Pipeline Attribute Data Fields
Recycled Water Master Plan
Carlsbad Municipal Water District

Field Name	Description	Valid Entries	Source
DIAMETER	Diameter of pipeline	Integers	City's pipeline GIS layer: "Diam" Field
MATERIAL	Pipeline material	ACP, CML&C, DI, STL, PVC (with class)	City's pipeline GIS layer: "PIPETYPE" and "PIPECLASS" Fields
ZONE	Pressure zone which pipeline is a part of.	318, 384, 550, 580, 660	City's pipeline GIS layer: "PressZone" Field.
YR_INST	Year pipeline installed. Adapted from year of "ASBUILT" field. For pipelines with unknown "ASBUILT" field, used "SIGNDATE" field.	Integer, 9999 used for unknown years.	City's pipeline GIS layer: "ASBUILT" and "SIGNDATE" Fields.
FACILITYID	Unique Identifier. Not included on pipelines not from the City's GIS.	WM#####	City's pipeline GIS layer: "FacilityID" Field.
FACILITY	Indicates whether an element is part of a facility (i.e., pipeline segments used for modeling purposes rather than actual pipeline in the ground)	Boolean (Yes or No)	Generated by Consultant
STATUS	Indicates whether a facility is active in the existing system.	ACT, ABAN	City's pipeline GIS layer: "STATUS" Field
WQ_GROUP	Group number for water quality pipe coefficient calculation (in calibration).	Integer	Created from material, age, diameter, or geographic location
RESID	Average chlorine residual under typical conditions	Number	Calculated from convergence of residuals for full system (during water quality calibration)
SRVC_AREA	Service area in which the pipeline is located (or owner).	CMWD, OMWD, VID, and VWD	Geographic location
EXP_LAT	Indicates which expansion segment future pipelines belong to	1 through 19, 99	For future pipelines, assigned as a part of future system analysis.
SPCLCNST	Indicates whether special construction conditions apply to future pipelines	SL (sliplining)	For future pipelines, assigned as a part of future system analysis.
PRIORCNST	Indicates whether a future pipeline is already constructed	Boolean (Yes or No)	For future pipelines, assigned as a part of future system analysis.

G.7 DATA SETS

G.7.1 Pipe Sets

Two pipe sets are used in the hydraulic model:

- EXIST
- FUTURE

The FUTURE pipe set was created to account for the potential decrease in friction factors as pipelines in the distribution system age. As outlined in Chapter 7, a Hazen-Williams roughness coefficient of 120 was used for pipelines over 20 years of age. For the future system, all existing pipelines were assumed to be greater than 20 years of age by this time.

G.7.2 Control Sets

Three control sets are used in the hydraulic model:

- CALIB
- EXIST
- FUTURE

The CALIB control set is used to establish the specific and detailed controls from the calibration period. This control set should only be used to replicate calibration conditions.

The EXIST control set represents the typical operations of the system as determined from discussions with District operations staff. Changes to the District's typical control strategies should be made in this control set.

The FUTURE control set was created based on the facilities added as a part of the future system evaluation. Some controls for existing facilities were modified to incorporate proposed facilities. Note that all future scenarios use the same FUTURE control set.

G.8 MODEL MAINTENANCE PROCEDURES

The hydraulic model is setup to use Query Sets for switching the active facility set within each scenario. If new elements are added to the model, they will behave as active until the model scenario is changed unless the STATUS field is properly populated. If the STATUS field is not populated, the new element will become inactive after switching scenarios. Ordinarily, this should cause the model to be resilient towards unintended modifications due to temporary analysis or "what if" scenarios, but this may create some unexpected errors if, for instance, junctions are inserted into an existing pipeline segment without the STATUS field of the junction set to match the pipeline.

Three query sets are included that are used for switching between scenarios:

- FAC_ACTIVE: Existing system and Calibration scenarios. Includes elements with the STATUS field of “ACT”
- FAC_PROPOSED: Future system scenarios. Includes elements with the STATUS field of “ACT”, “POTABLE”, “FUTURE”
- FAC_ULTIMATE: Ultimate system scenarios. Includes elements with the STATUS field of “ACT”, “POTABLE”, “FUTURE”, and “ULTIMATE”

To create elements within the existing system scenario (that are intended to remain in the existing system scenario), populate the STATUS field of all the elements with “ACT” (without quotes).

Note that some elements have STATUS values other than those stated above, for instance “NONE” or “ALT”. These elements were not intended to be active, but are added to the model for analyzing alternatives. For instance, there is a second equalization basin at Carlsbad WRF that has a STATUS value of “NONE”, used when analyzing if an additional equalization basin would assist in a particular scenario or alternative.